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JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION

STATISTICS AND ART[1]

By William F. Ogburn

My predecessors in office have discussed before you in a series of able addresses most of the aspects of statistics that are of interest to a general audience of social scientists. Yet, statistics is one of those words, like democracy or science, the meaning of which never seems exhausted. And so I have thought that by comparing statistics and art, some new light might be thrown on the place of statistics in the theory of knowledge. But if I am presumptuous in these expectations, I am sure such a comparison will be productive at least of an emphasis much needed today.

Statistics has been developed to give an exact picture of reality, while the picture that the artist draws is a distortion of reality. Even the portrait painter does not want to be photographic. The statistician wishes to make the probable error as small as possible; while the artist must always, so to speak, have an error. With some of the cubists, as, for instance, the painter of the famous picture of the so-called nude descending the so-called staircase, the purpose seems to have been to produce an error as large as possible. The artist, being impressionistic, is as little realistic as he can afford to be. But since art is a form of communication varying degrees of realism are demanded from age to age and from situation to situation, for without a sufficiently realistic medium the message is not adequately communicated.

The reason why the artist wants to change reality is that reality is unkind to him. He is uncomfortable in it and comes to have an inner message that is more beautiful to him than reality. The distortion he makes is an improvement of reality. His art is a product of his dream world expressed in terms of beauty.

Art is not, of course, the only sphere conspicuous for its departure from reality. The beliefs of the religious are signal distortions of reality. The belief in life after death is undoubtedly correlated with our hopes. Heavens are pleasant places in which to live, and the forms our souls take after death are such as we would like to have them take. The man of God finds this vale of tears and abode of sin a hard place to live in. And so the symbols, rituals and divinities in religion all serve to release him from the bonds of the here and now. Thus there is comfort and solace in religion, just as there is harmony in the works of the artist. Underlying both art and religion is the fundamental maladjustment of psychological nature to environment. But the way out is different. For the artist it is beauty; for the man of faith it is belief.

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[1] Presidential address at the Ninety-third Annual Meeting of the American Statistical Association, December 29, 1931.

Nor is the distortion of reality confined to the artist and the religious. The insane find a less attractive way out. Daydreamers and idealists find their escape in dreams. The unreal world of fiction, of stories of romance and adventure, are outlets for others of us whose adjustments do not satisfy our wishes. So universal is this habit of distorting reality that it may be said to be human. It is a habit that has to be unlearned by every statistician, the hardest task in his training.

The artist, the religious and the insane take more liberties with reality than other groups such as social reformers and promoters who are held within more reasonable bounds. While, therefore, there are many groups who misrepresent, artists may be singled out for comparison with statisticians because the distortions of artists are more like those which statistics seeks to prevent and to remedy.

This comparison may be approached by relating an incident that occurred once when I was attempting to mediate some labor difficulties in a steel plant. The morning I arrived the difficulties came to a head. I called at once to see the manager, and asked how many men were on strike. He replied that, indeed, there was no strike, that they were all just a happy family, but admitted that 200 men didn't report for work that morning. I then went out to talk with the agent of the union, and he told me excitedly that the plant would be closed completely by afternoon and that there were 15,000 out on strike at that moment. The true number proved to be about 9,000. Their statistics were not very accurate. They were both distorting reality in trying to make their respective worlds more comfortable for them. Here, as is so often the case, exact measurement eliminated errors due to prejudice.

Our language shows how strongly artistic and how little scientific we are. This is particularly true of the words of children, of poets, and of the folk. For instance, goldenrod is neither golden nor is it a rod; but goldenrod is a beautiful name as becomes a beautiful flower, and we like the distortion because of the charm in the associations it calls forth. We much prefer to call *delphinium tricorne* by the name of larkspur than by its scientific name, even if the resemblance of the flower to the spur of a lark is only slight. It is pleasant to think of so beautiful a songster as a lark having a spur like this lovely flower.

Similarly our adjectives are often colorful and do not lend themselves readily to accuracy. Thus the air is only hot or cold, or perhaps cool or warm. None of these expressions is very accurate, for we want this room 68 degrees warm, no more, no less. So we record refined measurement by expressing the adjective in terms of degrees. The adjectives tall and short have been refined into inches. Many adjectives still are enemies to accuracy, however. For, who would want us to say that the Mona Lisa was only 68 degrees beautiful. But perhaps the judges in a beauty contest for Miss America do have such a beauty thermometer. All inventions have a limited use at the beginning.

The point may be further illustrated by comparing the first five adjectives in Keats' "Ode to a Nightingale" with the first five adjectives from Egon Pearson's article on "The Test of Significance for the Correlation Coefficient" appearing in the JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION. Keats' adjectives are the following: drowsy, dull, happy, light-winged, and melodious; while Pearson's are the following: statistical, alternative, observed, little, and numerical. The number of adjectives per 100 words in Keats' Ode is two and one-half times as large as the number in Pearson's article on correlation. It is interesting also to note that H. G. Wells' *Outline of History* ranked in this regard just half way between Keats' poem and Pearson's article.

While statistics should render an exact account of reality, they do not always succeed in doing so. It is not so much that figures lie, as the old saying goes, as that liars figure. But if statistics were truly successful in preventing distortions, liars could not figure and get away with it. In social theory, in literature, and in philosophy there is no measure of the error, and the distorting effects of wishes are less easy to isolate than in statistics.

Statistics has given much more attention to the error in samples caused by a multitude of small causes, i.e., chance, than it has to the error due to a single large cause, as, for instance, prejudice. The theory of errors is one of the great achievements of science; but now more attention should be given to tests for the representativeness of samples from heterogeneous phenomena. Indeed, such a problem is not now thought of as a matter of statistics, but rather of psychology. For how can statistics prevent liars from figuring? Under the present status of conditions it is better to follow Freud than Gauss. Yet the place of statistics in the scheme of knowledge is as the champion of exactness and, surely, selection and representativeness in samples are of the greatest importance.

The shortcomings of statistics in this regard are most clearly seen in the case of statistical description. The point is well illustrated in a story told about Bernard Shaw and Sidney Webb. In the early days of the Fabians, Webb is said to have read a paper on the growth of municipal ownership, made up largely of statistical statements. Shaw criticized it as a grossly inaccurate presentation. Webb replied hotly with a challenge to show a single error in any statement. Shaw replied that of course all the statements were accurate, but that the whole, which was not the sum of the parts, was quite inaccurate since the municipalities that had not gone in for ownership had been omitted, making the paper give the picture of a stampede toward municipal ownership, which was far from the case. Curiously, the artist proved the better statistician. Description of multiple phenomena, such as a country, a people, or an epoch necessarily involves selection. That is why history must be rewritten in every age. Where the opportunities for selection are many, there we may expect to find the artist, the arch enemy of statistics. It may be argued that the scientist in drawing a generalization is doing what the artist does. It is true that they both select but the purpose of the scientist is to be exact while the purpose of the artist is to change reality.

Selection is at the very basis of our thinking which is largely a process of selecting a few memories and observations from the many possible ones. This sampling from the vast storehouse of our memories is not a very representative process. It is well known that we are prone to select that which is pleasing to remember. And so we recall "the good old days." Our memories of childhood are treacherous misrepresentations, while our national heroes such as the founder of our nation, become changed beyond all recognition. So powerful is this selective force that the face of reality is changed completely sometimes, as when we have hallucinations, which a sizeable percentage of us do have at times; that is, we hear voices when there are none and see mirages when there is nothing but atmosphere. It is this distorting influence of emotion and wishes that is more responsible for bad thinking than any lack of logic.

This selective nature of thought and observation is very well seen in the milder cases of manic-depressive insanity when the individual at one time can see nothing but clouds with no silver lining anywhere in the future, while a little later in their manic phase all will be sunshine with never a fear; views of reality quite unjustified by the facts.

Statistical descriptions are not wholly helpless before the selective tendencies. In most cases the statistical material is so scanty that one can ill afford to omit. The convention, today, is to survey all available statistical information. On the other hand, confining description only to statistical material itself produces a bias because of the omission of the non-statistical account. Furthermore the task of getting a representative sample from a complex universe is not insuperable. Indeed, the very raising of the question puts one on guard against biased samples. Still the problem of representative samples is of cardinal importance for statistics.

Further comparison of statistics and art reveals another important limitation of statistics. To the artist, statistical knowledge seems woefully inadequate. The artist is interested in imparting and receiving ideas that are rich in feeling tones. They must carry associations and awaken emotional recognition. Statistics seem bare. The inadequacy of statistical knowledge is like the inadequacy of theology to the religious. The artist that is in us wants understanding rather than statistics. But understanding is hardly knowledge; it is rather what knowledge means to us, i.e., to our rich collection of associations. Knowledge and understanding are at opposite ends of a continuous distribution. How many of us have an understanding of how far 93,000,000 miles are? Yet to know that the sun is that far away is very useful knowledge. Numbers as well as statistical symbols do not yet carry meanings as readily as does the folk language. The problem of the meaning, and presentation of statistics is most important as Mr. Leonard Ayres showed so clearly in his presidential address before the Statistical Association a few years ago.

The tests of knowledge are reliability and accuracy, not understanding. Indeed it is quite possible to have a satisfying understanding of something that doesn't exist. Thus one may understand how the sun moves around the earth. A person, untrained scientifically may live for a long time among another people and come to have a very good understanding of them; yet he would scarcely be called a scientist. His understanding would not be of that accurate, systematic, transferable kind called science. And so there would always be uncertainty as to how much he had misrepresented reality, unless it has been placed in objective verifiable form. To a visitor, Scandinavians may be tall, blue-eyed blonds with long heads and long faces, yet science shows that such an observation is a distortion of reality, for only about fifteen per cent of them fit this description.

Understanding comes to the extent that knowledge is correlated with past experiences and associations. Poets and novelists are much more successful in conveying understandings than statisticians and psychologists. This lack of appreciation of the difference between knowledge and understanding is thought to be the reason for much of the argument that the scientific procedures in the social sciences must be fundamentally different from those in the physical sciences. Statistical knowledge is peculiarly disappointing to those who fuse emotion with knowledge. The inadequacy of statistical knowledge is not so much a problem of statistics as it is a problem of the diffusion of statistics. This inadequacy is the very cause of its success, which rests on the fact that it is practical. Artists, poets, musicians and children are notoriously impractical, for reality to them is an inner reality. The statistician is essentially practical, interested in the outer reality and in eliminating the biasing effect of the inner feelings.

This close connection between statistics and the reality of the outside world explains a good many aspects of statistical development. For instance, it explains why certain impractical mathematicians do not make good practical statisticians. It also explains why statistics in psychology is different from statistics in economics. Statistical method must vary according to subject matter. Hence, statistics must be taught in the various departments of universities where it is applied. For these reasons statistics tends to break up into separate disciplines, somewhat as philosophy did. This tendency, by the way, may be of some significance for the future of the American Statistical Association. For instance the Statistical Association may take over the statistical activities of the other social science associations, or these associations may take over the jurisdiction of statistics dealing with their subject matter with the result that the Statistical Association confine its activities largely to methodology. The chief obstacle to the latter development is that methodological inventions arise from attacks on specific kinds of subject matter and cannot be developed apart from the special social sciences. Another possibility is that the Statistical Association may expand in such a way as to sweep more and more different subjects into its orbit, developing sections on medical statistics, engineering statistics, psychological statistics, biological statistics, in which case statistics will appear in the rôle of the unifier of the social sciences, perhaps as the one great social science. The rapid extensions of statistical technique into the various disciplines during the past decade are in this direction.

Before closing it may be well to affirm, lest there be misunderstanding, that accuracy and verification are not the whole story of science nor of statistics. It is quite recognized that hypotheses have to be formulated and that there is a drive back of research which calls for the constructive imagination of the artist, without which there could be no research. And it is also recognized that the aesthetic satisfaction that comes after a beautiful piece of research is somewhat akin to that which the artist experiences.

In conclusion, then, the apology for pausing a while this evening to reflect on the nature of art and of statistics lies in the great prevalence of the distorting tendencies of the human mind particularly in the social field and the great success which statistics has in combating these tendencies. We "carry around in our heads" pictures that are not like the photographs of reality. As children we begin life as artists personifying nature. We grow up still twisting reality out of shape with our faith and belief, as idealists, optimists, and pessimists, nervous, full of imaginary fears, doing all we can not to see life accurately. And in the occupations we follow we are bent on further twisting reality. As leaders, social reformers, religionists, journalists, entrepreneurs, promoters, advertisers we want to distort reality in ways peculiar to each occupation. As human beings we all wear colored glasses. This is the material nature has given us out of which to make scientists. No wonder they are so scarce.

It may be noted as a sort of complement to this array of human nature that the business of society can stand only a very few scientists and still fewer statisticians, perhaps not more than a fraction of one per cent. Nor does a statistician want to be a scientist more than a part of each 365 days. But we do need the results of statisticians, and in order to get them we need good scientists, not cross breeds.

Next, let us look at some of the issues on which we want scientific knowledge. There is war. One can hardly think of it without getting emotional. The word, war, almost suggests misrepresentation of facts. Another problem is the distribution of wealth, the factors surrounding which are so easily colored by our prejudices. Other problems with which we should deal, without distorting them, are strikes, labor unions, political parties, communism, religion, sex, the family, women, parents and children, races, tariffs, monopolies, eugenics; all problems capable of arousing the most violent prejudices. It is not surprising therefore that in the social sciences the forces of art have overshadowed statistics.

Nature, the subject matter of natural sciences, was once distorted and colored. The stars were candles hung out by the angels; thunder the voice of an angry deity. Strange as it may seem, nature was once the happy hunting ground of the wishful thinkers. But science succeeded in neutralizing it. We do not see ghosts, gnomes and fairies any more; and, parenthetically nature is still just as beautiful to the artist.

Can the neutralization of society be accomplished by the colorless statistician and scientist? For instance, shall we cease to personify social forces as great men and heroes? Shall we quit thinking of the Negro and the Eskimo as being inferior in mental ability? Shall we de-personalize heredity and admit that it has little or nothing to do with personality of normal human beings? Whatever the measuring scientist may find, the artist in us has given him a first rate task to do in regard to social institutions and their functioning. It is only desirable that society become neutralized to us as statisticians, not as artists or as human beings. Finally, however forbidding the neutralization of society may be, the reward is knowledge, control and power.

SEASONAL PATTERN AND SEASONAL AMPLITUDE: MEASUREMENT OF THEIR SHORT-TIME VARIATIONS

By Simon Kuznets, *National Bureau of Economic Research*

For a number of years statisticians have been concerned with the problem of measuring changes in the seasonal behavior of time series. But their attention has been concentrated on changes that were either gradual in character, or, if abrupt, demarked a break from one stable seasonal period to the next. To measure the latter was simple, for the stable seasonal indices could be computed for the period preceding and succeeding the break. Gradual changes, however, presented some difficulty. This was solved by applying the methods of determining secular movements to data which were so corrected as to throw into relief the seasonal element, i.e., were freed as much as possible from the secular trend, cyclical movements and sometimes even random changes.

But besides such variations in seasonality, two other groups of changes appear, upon close study of the seasonal problem, quite important: (1) the short-time shifts in seasonal pattern, pattern being defined as the relative seasonal position of the months in the year, regardless of the general amplitude of the seasonal swing; (2) the short-time shifts in seasonal amplitude. Both groups of changes are confined to variations, irregular in character, that reveal themselves within a comparatively short period. This irregularity within short spans of time is distinctive and calls for new methods.

Short-time shifts in seasonal pattern, to consider the less important group of changes first, occur quite frequently, and their existence can be ascertained rather easily. The best example is provided by the shift of the Easter holiday from March to April and its influence on retail sales. The effect on department store sales has been measured empirically by the Federal Reserve Board statisticians.[1]

Such shifts in seasonal standing which may occur from one year into the next, without any regularity, are characteristic of many more groups of series than might at first be thought. All the time series which reflect the movement of agricultural crops are subject to them. In one year wheat may begin to be marketed late in July, the next year in August, the third year in early July. The cotton crop may begin to be harvested in one year during August, in the other in September. Such shifts obviously arise from the climatic conditions in the central geographic belt which supplies the bulk of the crop and which one year may make for an early crop, the other year—for a late crop. In addition, there are cases in which the crop comes from two distinctly different geographical sources (e.g. spring and winter wheat) which have normally quite different harvesting dates. Then the shift in the proportion of the two sources of the crop may affect the seasonal pattern (and sometimes even the seasonal amplitude) of the series which reflect the movement of the commodity as a whole.

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[1] See this Journal, December, 1927, pp. 493–496.

Thus short-time shifts in pattern affect all the numerous time series that deal with the flow of agricultural crops to markets, shipments of crops from central markets, exports and stocks of crops at the primary stages of distribution, etc. But a similar group of seasonal factors may affect the series which portray seasonal variations in consumers' demand due primarily to climatic conditions. To take an extreme example, the sales of straw hats, allowing for constancy of demand, may begin about the middle of May, or in early June, depending upon the particular weather conditions in the given year. Shifts in the exact date at which the new climatic season is really ushered in will affect the seasonal pattern in the sales of apparel, consumption of seasonal foods, sometimes even the beginning of construction operations, shipping on lakes, etc.

The importance of these short shifts in seasonal pattern, and correspondingly the complexity of their measurement, depends upon whether one conceives this shift as affecting only a couple of months or all twelve months with which the seasonal measurement deals. If, as in the case of Easter, the shift is supposed to affect the seasonal standing only in March and April, this type of seasonal changes becomes limited in significance. The measurement then is reduced to an adjustment for these two months, derived from comparison of the seasonally corrected data (by a stable or a progressive seasonal index) for various subperiods, distinguished by the dates of the disturbing holiday. In some cases, however, it might be argued that the shift in the beginning of a climatic seasonal affects the standing of more than just the preceding and current month. In this case, one way out is to break the series into subperiods, within which there is no shift in the seasonal factor affected, and compute separate seasonal indices. The other alternative, the measurement of the seasonal factor by a continuous time series, and elimination of seasonal effects through correlation, seems to be impracticable.

The second group of changes appears more important in character, and is at the same time capable of more precise measurement.

These are changes in seasonal amplitude from year to year. A brief survey of the seasonal factors that make for such changes will illustrate their pervasive character. The best example is provided by a series which measures stocks of an agricultural commodity, such as cotton.

Stocks of cotton at public warehouses (or at mills) in the United States show a seasonal swing of a rather considerable amplitude. The seasonal declines constantly from the beginning of the calendar year to about the end of July or August, and then, as the new crop comes in, rises to a peak in November or December. The amplitude of this seasonal in a given year will depend upon a number of factors of which the most important seem to be as follows: (1) the relative size of the crop in the corresponding year as compared with that of the current year; (2) the demand for cotton during the current year; (3) the absolute volume of stocks during the current year, especially as compared with the average size of crop of the current and the preceding years. If the last year's crop was poor, if the demand (both domestic and export) during the current year was large, if, in consequence of these two factors or for some other reason, the absolute level of the stocks during the first three quarters of the current calendar year was low, and if the current year's crop is comparatively good, the seasonal swing of cotton stocks during the given year, measured by a relative seasonal index (running in terms of deviations from 100) will be large. If on the other hand, the preceding year's crop was large, if the demand during the given year was rather small, if in consequence of these two factors, or for some other reason, the absolute volume of stocks during the first three quarters of the year was large, and if the current year's crop is rather poor, the relative seasonal index during the given year will obviously have an amplitude much smaller than the average. Such fluctuations in seasonal amplitude, with the pattern persisting, might occur without any gradualness or regularity from one calendar year to the next. No matter how short the period for which the stable seasonal index is computed, and it should not be shorter than four or five years, it can hardly cover a period within which such fluctuations in amplitude are absent. And it is also clear that no method of studying progressive seasonality will measure the fluctuation. What is needed is an index which will reflect irregular, year-to-year changes in seasonal amplitude.

The same factors that thus determine variations in seasonal amplitude in stocks of cotton will affect the seasonal swings in the flow of cotton from farmers to the cotton houses, exports of cotton from the United States and even the consumption of cotton by the textile mills. In the case of all agricultural raw materials, seasonality in supply is reflected not only in the flow and stocks of the commodity in its raw form, but to a certain extent even in its consumption by the industrial user. In all the numerous time series which record this activity, there will be fluctuations in seasonal amplitude from year to year, arising from the variations in the size of crop, the geographical distribution of the crops, and sometimes the fluctuations in the size of the carryovers.

On the other hand, series which reflect seasonality in final demand due to the direct influence of climatic conditions will be subject to the same type of variation in seasonal amplitude. In a year marked by both mild winter and comparatively cool summer, the seasonal swing in the sales of cool drinks, electric fans, and light apparel will not be as marked as in a year which has a very hot summer and a rather cold winter. The demand for a very considerable number of commodities is variable because it reflects the succession of climatic seasons. And any changes in the seasonal amplitude of the climatic conditions will tend to be reflected in the seasonal variation of the corresponding time series.

Seasonal variations in the supply of raw materials and the demand for finished goods tend to be reflected in the industrial consumption of raw materials, industrial production of finished goods, stocks and flow of both groups of commodities. Any variations in seasonal amplitude in the supply of raw materials or the demand for finished goods will, therefore, tend to be passed on through the numerous ramifying links of the economic system. But, besides, there is an additional group of factors which determine the extent to which seasonality in supply of materials or demand for finished goods is allowed to influence the flow of industrial production or intermediary stocks. These factors constitute, therefore, an independent source of possible variations in seasonal amplitude.

Thus, for example, the adoption of hand-to-mouth buying policy by retailers and wholesalers of manufactured goods means that orders or purchases on the part of these two business groups begin to reflect much more closely than before the seasonal variations in the demand for final consumers. If before the inauguration of such a policy, dry goods' retailers and wholesalers bought ahead of the season and spread their orders throughout the year, after the new policy came in, retailers' and wholesalers' purchases reflect fully the seasonality of consumers' demand which then falls with full brunt on the manufacturers. Here is, therefore, a change in seasonal amplitude in the purchases by retailers and wholesalers, in shipments to them, in stocks kept by them. In his turn the manufacturer, faced with this situation, may either keep larger stocks and thus take over the function performed before by the trades, or allow production to become more seasonal, i.e. produce just when orders come in. In this case we should observe a change in seasonal amplitude in the stocks kept by manufacturers, or in industrial output itself.

Now, such changes in business policy may occur from one year to the next. The degree to which the uncontrollable seasonal variations in the supply of raw materials and the demand by final consumers are allowed to affect the controllable processes of industrial manufacturing and of trading, depends very much upon the general factors which determine the keeping of stocks, either in the form of commodities or in the form of machinery. And these factors may vary from year to year, producing corresponding changes in seasonal amplitude. We are thus likely to, and actually do, find variations in seasonal amplitude not only in series which reflect directly uncontrollable climatic seasons, but even in series which measure controllable business activity.[1]

It might be said that all these changes in seasonal amplitude are not seasonal changes at all. It might be pointed out, and with some basis, that variations in seasonality due to factors just discussed are really a reflection of the cycle in the supply of crops, in the demand for the seasonally affected commodities, or in the factors determining business planning. This is true. But while the originating factors may be cyclical in character, the result is to produce discontinuity in the monthly data, a discontinuity directly associated with the seasonal behavior of the series. By failing to correct for these effects, we fail to eliminate properly the seasonal variations in the series. One may call these variations in seasonal amplitude the effects of cycles on the seasonal. But these effects have to be measured, if one wishes to learn their magnitude, obtain a clear indication as to the factors which may explain them, and correct the series so as to attain better continuity and smoothness for the purpose of better studying the cyclical or other continuous elements.

How can these year-to-year changes in seasonal amplitude be measured? The answer lies in the suggestion made some years ago by the Russian statisticians, Bobrov[2] and Tschetverikov to use the coefficient of regression.

If we compute either a stable or a progressively moving seasonal for a series, we may assume this seasonal to represent the independent variable, to be called *s*. The task then is to find out whether in any given year the series reflects the full seasonal amplitude of the stable or progressive index, only a part of it, or perhaps an amplitude in excess of it. In order to answer this question the data must first be treated in such a way as to throw into relief the seasonal changes and to reduce as much as possible the secular and cyclical movements. This may be accomplished by computing a twelve-months moving average, or a two of a twelve (which amounts to a thirteen-months moving average, extreme months at half weight). The dependent variable is then the original series, taken as relative of the moving average as 100. Let us call this variable d.

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[1] See W. Floyd Maxwell, "Revised Index of the Volume of Manufacture," *The Review of Economic Statistics*, May, 1929, pp. 60–70.

[2] See S. P. Bobrov, *Economicheskaya Statistika*, pp. 429–30, Moscow, 1930.

Then, for a given calendar year the coefficient of regression is

$$b_{ds}=\frac{\Sigma ds}{\Sigma s^2}.$$

To compute the formula, we take for s the deviation of the seasonal index from 100 (these are deviations from the true mean, since the seasonal index is centered on 100); for d the original data expressed as relative of the moving average, but taken as deviation from 100 (this is a deviation from an assumed mean, since only rarely will the deviations from a twelve-months moving average exactly balance during the year). What the formula yields then is the unit change in the data with a unit change in the seasonal index. If the coefficient is equal to 1, the seasonal amplitude during the given year is exactly equal to the seasonal amplitude of the stable seasonal index (or the progressive seasonal for that year.) If the coefficient is less than 1, the seasonal amplitude during the given year is smaller than that of the stable seasonal index. If the coefficient is larger than 1, the seasonal amplitude is larger than the average.

An example of computation for one year, 1924, of this coefficient of regression or *amplitude ratio* is given in Table I, for the series of cotton stocks in public warehouses.

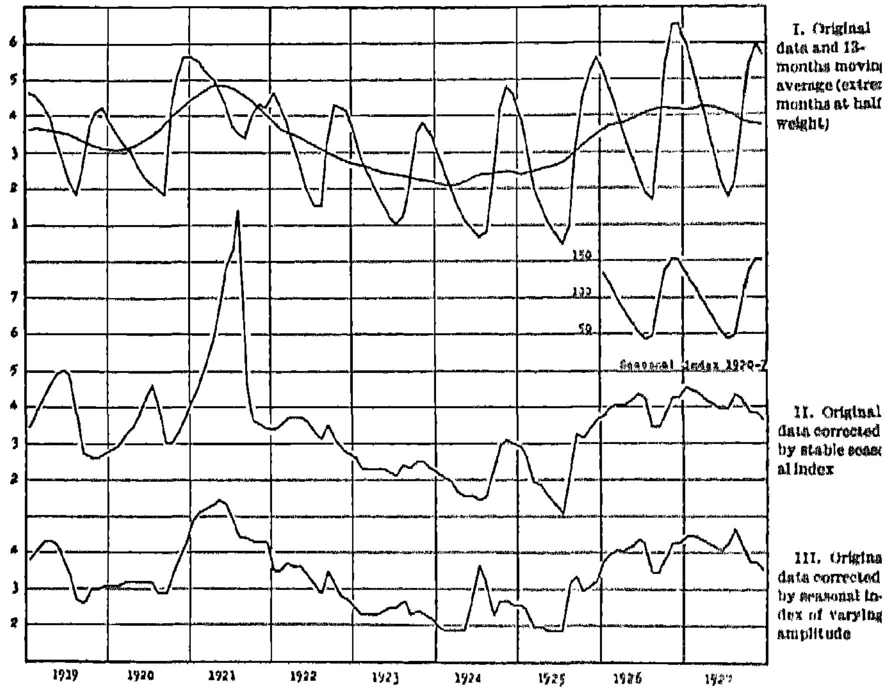
TABLE I

Months	Original data (millions of bales)	Moving average (13 months)	Relative deviation d (per cent)	Seasonal index (years 1920–27) taken as deviation from 100) s	Products ds	s^2
January	2.96	2.16	+37	+35	+1295	1225
February	2.50	2.13	+17	+20	+ 340	400
March	2.00	2.11	− 5	+ 2	− 10	4
April	1.51	2.14	−29	−13	+ 377	169
May	1.13	2.21	−49	−30	+1470	900
June	0.88	2.30	−62	−45	+2790	2025
July	0.67	2.39	−72	−55	+3960	3025
August	0.80	2.45	−67	−51	+3417	2601
September	2.07	2.47	−16	− 7	+ 112	49
October	4.23	2.48	+71	+39	+2769	1521
November	4.80	2.48	+93	+53	+4929	2809
December	4.62	2.48	+86	+52	+4472	2704

$\Sigma d=+4 \quad \Sigma s=0 \quad \Sigma ds=+25{,}921 \quad \Sigma s^2=17{,}432$

$$b_{ds}=\frac{+25{,}921}{17{,}432}=+1.487$$

RAW COTTON—STOCKS IN PUBLIC STORAGE, 1919–1927



The importance of this factor of varying seasonal amplitude may be seen from a glance at the chart. The upper section presents the original data with the two item average of a twelve-months moving average passed through it. The importance of the seasonal swing is quite apparent. The stable seasonal index is derived from the deviations from the line of moving averages.

The second section of the chart is the original data corrected by the stable seasonal index. While a large part of the seasonal swing has been taken out, some of it remains, as may be seen from an inspection of the chart, especially in comparison with the seasonal pattern plotted there. In some years, such as 1924 and 1925, the corrected data retain a movement positively associated with the stable seasonal pattern. In these years the seasonal amplitude must have been larger than the average, and as a result, the application of the stable seasonal index has "undercorrected" the series. In other years, such as 1921 and 1920, the corrected data exhibit a movement directly inverted to the stable seasonal pattern. In these years the seasonal amplitude must have been smaller than the average, and as a result, the application of the stable seasonal index has "overcorrected" the series. It is to be seen that no matter how short the period for which the stable seasonal could be computed, no correction for this shifting amplitude would have resulted. Neither can a progressively moving seasonal deal with the problem.

The coefficients of regression, or, as they might be called in this case, the amplitude ratios, may help to correct this improper elimination of the seasonal. For the period covered by the chart, the amplitude ratios for successive calendar years were as follows:

1919....	0.62	1922....	0.94	1925....	1.32
1920....	0.63	1923....	1.13	1926....	1.01
1921....	0.42	1924....	1.49	1927....	1.05

We can apply these ratios to the deviations of the stable seasonal index from 100, and thus obtain new seasonal indices for each calendar year. Thus for the year illustrated above, the amplitude ratio was 1.49. Applying it to column 5 we obtain the following seasonal index for the year 1924:[1]

Months	Deviations from 100	Index	Months	Deviations from 100	Index
January..................	+52	152	July..................	−82	18
February..................	+30	130	August..................	−76	24
March..................	+ 3	103	September..................	−10	90
April..................	−19	81	October..................	+58	158
May..................	−45	55	November..................	+79	179
June..................	−67	33	December..................	+77	177

The correction by these new indices gives us the line in the bottom section of the chart. It may be seen that the series is now much better corrected for seasonal than before.

The use of the coefficient of regression as illustrated above is contingent upon the fact that the seasonal pattern will be reflected persistently from year to year and that only the seasonal amplitude changes. It is assumed that the other changes in the deviations from the twelve- or thirteen-months moving averages, besides the seasonal, are distributed in a way indifferent to the seasonal pattern, and that the seasonal is the most important element of change there.

However, these other factors may affect the seasonal pattern in any year. If for a given year, a low amplitude ratio or coefficient of regression is obtained, this result might be due either to the fact that while the seasonal pattern persisted, the amplitude during the given year did decline, or to the fact that there had been a shift in seasonal pattern during the year. For purposes of correction, as demonstrated above, the distinction is not important. But for purposes of interpretation of the movement of these amplitude ratios from year to year, it is of importance. And it is only a short step from the coefficient of regression to the measure which would indicate whether the pattern itself persists from year to year, viz. the coefficient of correlation.

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[1] In computing the new seasonal index by the application of the amplitude ratio a difficulty may arise when the ratio is very large. For then the negative deviations of the stable seasonal index from 100 in some of the months, when multiplied by the amplitude ratios, may become close to −100 or [illegible] even less. In such cases it might be better not to divide by the seasonal index, but to subtract its deviations from 100 (adjusted by the amplitude ratio) multiplied by the average value of the series for the period. If the seasonal index for some month becomes algebraically smaller than −100, it might be taken as −100. The corrected series thus becomes discontinuous for this month.

The coefficient of correlation measures the association between the variations of the two variables, regardless of their average amplitude. Hence, it will show whether or not the pattern indicated in the stable seasonal index is reflected closely in the movement of the data taken as deviations from the thirteen-months moving average. The formula for this coefficient in the terms above is

$$r=\frac{\Sigma ds}{\sqrt{\Sigma s^2(\Sigma d^2-C^2)}}.$$

The correct sum of ds and of s^2 is given in the computation of the amplitude ratio, and the sum of d^2 can be easily computed from Table I. The correction C is given by the algebraic sum of the d's taken for the year. This algebraic sum is found in column 4 of Table I.[2] The r's for the years covered in the illustrative chart are as follows:

1919....	0.89	1922....	0.89	1925....	0.98
1920....	0.95	1923....	0.98	1926....	0.98
1921....	0.89	1924....	0.98	1927....	0.99

It may be seen that the values are very high throughout, and that therefore the variations in the amplitude ratios may be conceived as bona fide changes in seasonal amplitude, with the permissible assumption of a highly persisting pattern.

The amplitude ratios, indicated above, supported by the corresponding r's, may be computed not only for successive complete calendar years, but for any successive complete years of twelve months each. Instead of counting the year from January to December 1920, one may count from February 1920 to January 1921, March 1920 to February

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[2] It might be objected that the use of the Pearsonian r for correlating the stable seasonal swing and the swing observed in each current year is improper, since the case involves measurement of annual cycles, and not distributions of the normal type. Consequently, it ought to be more advisable to use first moment correlation, or some such measure as the index of similarity of Gressens and Mouzon. (See this JOURNAL, December 1927, pp. 483–492.) But these measures do not employ the concept of regression and do not provide the proper coefficient of regression. And since a measure of the latter type is needed for the amplitude ratios, it might be better to use the established indices, with full regard, of course, for the possible influences of extreme items.

1921, etc., and thus obtain both amplitude ratios and *r*'s for years removed by one month successively. Thus, for the period covered by the chart the amplitude ratios and the *r*'s for years running from July to June are as follows:

Years	Amplitude ratio	*r*	Years	Amplitude ratio	*r*
1919–20............	0.66	0.96	1924–25..........	1.57	0.98
1920–21............	0.53	0.82	1925–26..........	1.14	0.98
1921–22............	0.55	0.96	1926–27..........	1.06	0.99
1922–23............	1.00	0.98	1927–28..........	1.02	1.00
1923–24............	1.22	0.99			

This change from the calendar year involves certain complications if one wishes to use the resulting amplitude ratios for a better correction of the series. First, if the underlying seasonal is moving instead of stable, the seasonal indices for non-calendar years will not be centered on 100, and therefore a correction of the *s*'s in the computation of the amplitude ratio and of the *r* is needed. Secondly, even if a stable seasonal is used, the correction of the seasonals on the basis of amplitude ratios running in non-calendar years is difficult, because the corrected seasonal index ceases to be centered on 100. Thus, if for adjusting the seasonal standing for January one uses the amplitude ratio for the year running from July 1920 to June 1921, and for adjusting February 1920, the year August 1920–July 1921, the changes in the amplitude ratio may result in the fact that the amount of adjustment introduced into the twelve months of 1920 does not balance algebraically. Of course, the same difficulty is true of non-calendar years even when we adjust by amplitude ratios based on calendar years only. The adjustment introduced into the year July 1920–June 1921 is not likely to balance. We have here the same situation that is created by a progressively moving seasonal correction. Only for one set of years can the seasonal correction balance. But in using the moving amplitude ratios not even one set of years will have a seasonal correction centered on 100.

For this reason the use of moving amplitude ratios for correction is not altogether practicable. But they are more important in throwing light on the movement of seasonal amplitude itself, a measurement of a new type of change which may turn out to be of considerable analytical interest. For the amplitude ratios permit the study at close range of the shift in the seasonal perturbations of the economic activity which is reflected in the time series. It permits the establishment of any shifts in seasonal variations from one link of the distributive system to another; of changes in seasonal amplitude within much shorter periods of time than can be covered by stable seasonal indices. To put it differently, the amplitude ratios buttressed by the *r*'s permit study of the short-time changes in seasonal swings, variations which may be primarily interpreted as the short time, retroactive effect of the cyclical movements on the seasonal recurrence patterns.

In conclusion it might be interesting to present a set of measures for a connected group of series. In Table II, for series reflecting movement of hogs, stable seasonal indices were in most cases computed for two periods. But the amplitude ratios have been rendered comparable by recomputing them to the base of the average sigma of the deviations of the stable seasonal indices from 100.

TABLE II

AMPLITUDE RATIOS AND *r*'s FOR THE SEASONALITY IN RECEIPTS, SHIPMENTS AND COMMERCIAL SLAUGHTER OF HOGS, 1919–1929

Years (calendar)	Receipts at primary markets		Shipments from primary markets		Commercial slaughter		*Average price per 100 pounds at Chicago (year beginning October)
	Amplitude ratio	*r*	Amplitude ratio	*r*	Amplitude ratio	*r*	
1919	1.37	0.99	1.20	0.96	1.32	0.99	14.65
1920	1.17	0.93	1.06	0.94	1.09	0.93	9.06
1921	0.90	0.97	1.27	0.95	0.77	0.95	9.01
1922	0.80	0.98	1.02	0.93	0.73	0.92	7.93
1923	0.81	0.97	0.79	0.95	0.77	0.95	7.58
1924	1.19	0.93	1.20	0.91	1.09	0.94	11.59
1925	1.14	0.94	1.16	0.91	1.00	0.92	12.18
1926	0.67	0.97	0.76	0.93	0.70	0.97	10.70
1927	0.65	0.78	0.54	0.79	0.70	0.82	9.68
1928	1.27	1.00	1.02	0.92	1.23	0.90	10.20
1929	0.83	0.94	0.82	0.95	0.85	0.95	

* See *Yearbook of Agriculture*, 1930, p. 853.

The similarity of the amplitude ratios in the three series, as well as the consistently high values of the *r*, indicate that we are dealing here not with any vagarious result of statistical manipulations but with a measure, approximate though it may be, of a significant group of changes. This impression is confirmed when the course of prices, given in the last column of the table, is compared with the movement of the amplitude ratios. The agreement in the movements is quite striking. When prices go down, as they did in the years 1920 to 1923, the amplitude ratios decline also. When prices go up, as they did in the years 1924 and 1925, the amplitude ratios, in at least two of the series, show a rise. The same agreement occurred during the rise in prices in 1928. It would seem then that with declining prices there is less of a concentration of hog movements in the seasonally heavy months, and relatively larger volumes of hog shipments in the other, seasonally slack, months. Such a result may be explained by a waiting policy on the part of the producer, by a greater inclination to wait with the marketing of hogs in periods of declining prices. On the contrary, in periods of rising prices there is a tendency to ship more in the seasonally high months, obviously in order to take advantage of the favorable markets as promptly as possible.

Table II provides a good case in which fluctuations in seasonal amplitude seem to be a direct effect of changing business conditions and of consequent changes in business policy on the part of economic agents. In view of this nature of the variations in seasonal amplitude, they present considerable interest from the point of view of an economist. The quantitative, absolute magnitude of these changes may be small, although in agricultural series they are often considerable. But they throw light on significant economic phenomena and their implications. For this reason, the National Bureau of Economic Research, in its study of Seasonal Variations in Industry and Trade, lays some emphasis on measuring these variations in seasonal amplitude. It is hoped that the results will justify attention to these groups of changes and thereby contribute to a greater knowledge of the underlying economic factors.

INDEXES OF THE PHYSICAL VOLUME PRODUCTION OF PRODUCERS' AND CONSUMERS' GOODS[1]

By Y. S. Leong, *The Brookings Institution*

Two attempts have been made to measure the production of consumers' goods and of producers' goods by months. Snyder, in constructing his index of the "Volume of Trade," subdivides his production series into two groups, for which he builds up two distinct indexes, which he designates as "Producers' Goods" and "Consumers' Goods."[2] The Harvard Economic Society's monthly index of the Volume of Manufacture in its earlier form appeared as a combination of three sub-composite indexes measuring the physical volume of output of (1) basic materials, (2) equipment and vehicles and (3) consumption goods.[3] But both Snyder's and the Harvard Society's measurements are not strictly indexes of production in the same sense as are our measurements of price levels, which are weighted averages of prices converted into relatives, but are really indexes representing the production cycles of these types of goods, for the method of construction consists in ascertaining the trend of each series and in taking the weighted arithmetic mean of the relatives, computed on the basis of their respective ordinates of secular trend adjusted for seasonal variation equal 100.

There is still room, then, for the construction of monthly index numbers to measure the actual changes in the physical volume of production of the two types of manufactured goods in the United States, and it is the object of this paper to present two sets of measurements: an index of the volume of producers' goods and an index of the volume of consumers' goods, for the years 1919–1929. By combining these two measurements we obtain the index of manufactures. For reasons which are shown below, it seems desirable to present a separate index of the volume of consumers' goods from which automobile production is

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[1] The writer wishes to acknowledge his indebtedness to Dr. C. O. Hardy of the Institute of Economics and to Mr. D. S. Thompson of the Division of Research and Statistics, Federal Reserve Board, for advice and suggestions; to the Brookings Institution for statistical aid and for the grant of a research fellowship which made this study possible; to Mr. S. B. Akers for supervising the computations and to Mr. R. P. Ward for drawing the charts.

[2] Carl Snyder, "The Index of the Volume of Trade, Second Revision," this Journal, June, 1928, Vol. XXIII, pp. 154–163.

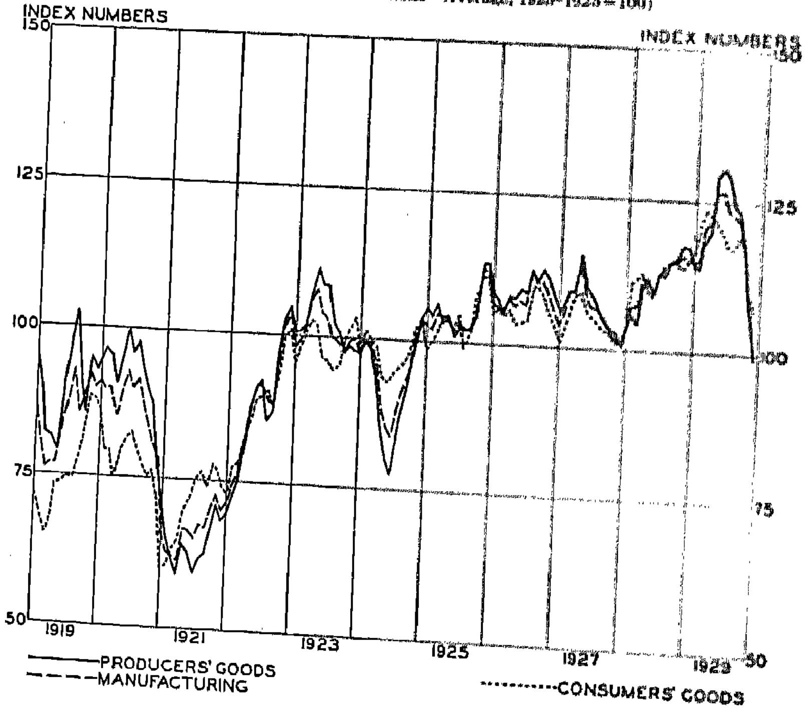
[3] E. E. Day, "Cyclical Fluctuations of the Volume of Manufacture," *Review of Economic Statistics*, January, 1923, Vol. V, pp. 30–60. In the recent revision of its index of the volume of manufacture, the Harvard Society has abandoned its former classification, preserving only the basic material grouping. See W. F. Maxwell, "The Revised Index of the Volume of Manufacture," *Ibid.*, May, 1929, Vol. XI, pp. 68–109.

excluded. For comparative and other purposes it is also deemed instructive to adjust these four indexes in their final form for trends and seasonal variations. The actual indexes[1] of producers' goods, of consumers' goods and of manufactures are shown in Chart I, the same indexes in adjusted form (trends eliminated) in Chart II. The figures underlying the charts are given in the appendix. The data which enter into the indexes, their sources, the weights assigned and the relative importance of each series as shown by the percentages computed on the basis of the weight assignments are also presented in the appendix.

CHART I

INDEXES OF THE PRODUCTION OF PRODUCERS' GOODS, OF CONSUMERS' GOODS AND OF MANUFACTURES

(Adjusted for Seasonal Variations—Average, 1923-1925 = 100)



We have selected sixty monthly physical unit series, covering twelve industrial groups.[2] Because our indexes are of historical interest rather than for current use, we are able to broaden their scope to the greatest possible extent by including a number of series which the compiler of indexes for current use must discard either because the data are not promptly published or because, though currently available, they are subject to later revision. Considered purely from the numerical standpoint, the inclusion of sixty out of the hundreds of industries manufacturing thousands of products cannot be said to be entirely adequate. Fortunately for our purposes most of our series are relatively important—important as measured by the values added by manufacture and as judged by the fact that they may be taken to represent directly or indirectly the output of a large number of products

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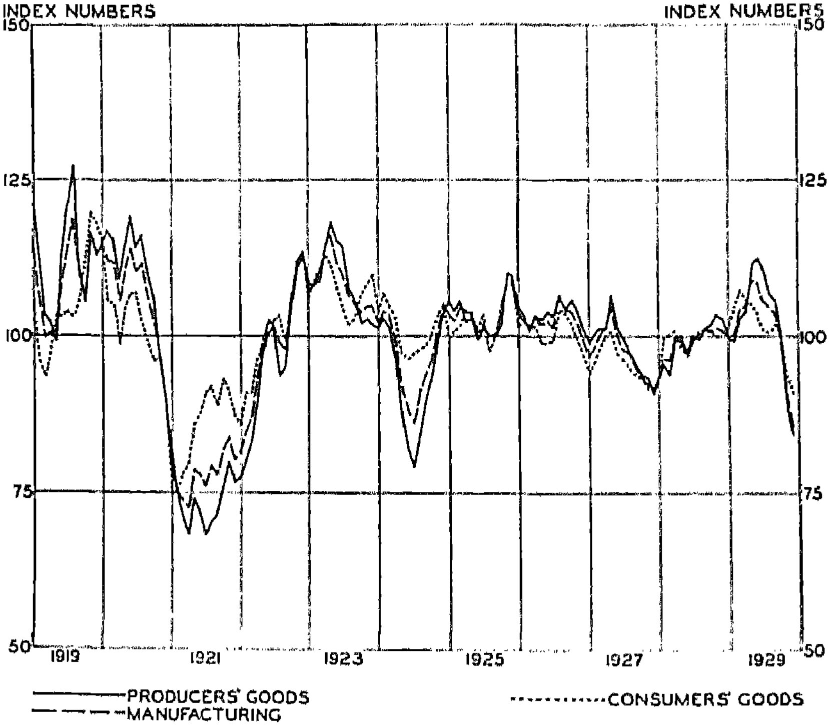
[1] The actual indexes in Chart I and the adjusted indexes in Chart II are corrected for seasonal variations.

[2] In making the study of the underlying statistics for the indexes, I am indebted for assistance and suggestions to a number of persons connected with the various government bureaus. In particular, ac-

CHART II

INDEXES OF THE PRODUCTION OF PRODUCERS' GOODS, OF CONSUMERS' GOODS AND OF MANUFACTURES

(Adjusted for Seasonal Variations—Normal = 100)



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knowledgment is due to Mr. J. F. MacDonald of the *Survey of Current Business* for furnishing me with the latest revised figures compiled by his office; to Dr. C. E. Parry and Miss A. Joy of the Division of Research and Statistics, Federal Reserve Board, for supplying me with certain series; and to Mr. LeVerne Beals, Chief Statistician, Census of Manufactures, and others connected with the Bureau of the Census, for advice with respect to the reliability of certain production data.

of industries for which we have no data, and of whose broad movements our component series may be trusted to give us a fair approximation.[1] We do not, for example, have any satisfactory statistics of machinery produced, or of finished or semi-finished steel products, but we may rely upon the output of steel ingots to give us indirectly a general indication of the concurrent movements of these industries into which steel ingots largely if not wholly enter as basic material. Certain of our series, which while satisfactory in so far as they may be taken as broad measurements of the productive activities of those industries manufacturing unfinished products, are not so useful for the purpose of representing the changes in those industries which are engaged in the more advanced stages of fabrication. For example, in the textile industries, for which we have practically no production figures, the substitution of data showing the volume of basic raw materials consumed currently, while it may be serviceable for the purpose of registering the output of yarn and unfinished cloths, is not to be depended upon because of changes in quality to reflect the changes in the manufacture of finished cloths and clothing. Still less may it be relied upon to give us a trustworthy picture of the variations in the volume of the finished products of related industries fabricated from new materials, of which we have not even consumption data, such, for example, as the rayon industry.

Having selected the basic data, we must next classify the series into producers' goods and consumers' goods. As the distinction between the two types of goods is not a clear one, our classification in some cases must necessarily be more or less arbitrary. For our purpose, we designate those series which are intended to represent fabricated goods for immediate or near to immediate consumption as consumers' goods, such as flour, and those other series which are intended to represent unfinished goods, such as yarn, or goods which are used to produce other goods, such as machinery, as producers' goods. On the basis of this distinction we have divided our sixty series into the two groups —29 as consumers' goods and 31 as producers' goods. An examination of the items of the two groupings will make evident the fact that the producers' goods index is more comprehensive than the index of consumers' goods. This shortcoming of the consumers' goods index is to be explained by the fact that we are unable to obtain satisfactory statistics of the output of fully fabricated goods and that hence we are forced to substitute data showing the production of simple articles and in some cases, figures representing the amount of raw materials currently consumed by the industries. Of course, where the industries, as in the iron and steel industries, manufacture goods largely of the producers' type, in which the time relationship and the magnitude of cyclical movements of the simple as well as the elaborated products are practically similar, data measuring the changes in the volume of goods of lower orders may well be substituted, in the absence of better and more refined figures.[1] But in other industries, which produce both types of goods and of which the final products are largely destined for final consumption, the use of crude data, such as figures of current consumption of raw materials, to represent consumers' goods is questionable. Undoubtedly the scope of our index of consumers' goods should be extended to include additional data of fabricated products for direct consumption. In particular, we need direct production statistics of hardware and machinery for household use, wood and other household furniture, musical instruments, drugs and chemicals for ultimate consumption, canning and preserving and cloth and clothing.

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[1] The average value added by manufacture in all industries for the census years of 1923, 1925 and 1927, computed from the biennial census figures amounts to $27,000,000,000, of which amount, $13,000,000,000 or 48 per cent is directly, and $21,000,000,000 or 78 per cent is directly or indirectly represented by our sixty series.

The index of producers' goods, being broader in scope and having included in its composition more reliable component series, is undoubtedly a more trustworthy gauge of the producers' type of production than is the index of consumers' goods of the consumers' type. Only three of the larger industries—the chemical, the clay products and the railroad repair shops—are without direct or indirect representation in the index; of these, the chemical is the most important. To be sure, in some industries, the measurement of their productive activities is possible only indirectly; for instance, machinery production is represented only indirectly by the concurrent output of iron and steel. But despite these shortcomings, we can perhaps safely conclude that our index of producers' goods is as comprehensive and as representative a measure as can be devised at this time to register the movements of the output of the producers' type of goods.

The classified individual series are next combined into composite index numbers by the "aggregative" method.[2]

Our system of weights is based upon the figures showing "value added by manufacture," presented biennially by the Census of Manufactures. As some of our series represent more important industries than do others, and as others cover a greater proportion of the industries which they represent than do others, it has been found necessary to assign

[1] Production statistics of lower order of goods do not of course register the degree of fabrication of higher order of goods. Consequently the use of crude data to represent the production of consumers' goods, whose quality is improved from year to year, is certain to understate their long-time growth.

[2] This method is employed by the Federal Reserve Board in computing its "Index of Industrial Production" (*Federal Reserve Bulletin*, March, 1927, Vol. XIII, pp. 173-175), and by Perry and Silverman in constructing their index of the "Physical Volume of Canadian Business" (this JOURNAL, June, 1929, Vol. XXIV, p. 137).

a weight to a given series to register its importance, that is, the value added by the manufacturing process to the industry which it represents, and to impute additional weight to represent value added either in related industries, or in the later stages of fabrication in the same industry. The Census of Manufactures in segregating products by industries, in classifying industries by major industrial groups and in reporting value added data in conformity with its grouping system, has made it convenient to adhere to its scheme of classification in assigning weights. Our series are then arranged by industries and by major groups in accordance with census classification. The assigned value added for each group is distributed among the industries representing the group in proportion to their actual respective value added as reported by the census. In turn the distributed value added for each industry is reapportioned among the constituent series representing products in proportion to the reported value added by manufacture for the respective product, or where such data are not available, in proportion to the value of the product. The final assignment of value added figures to groups, industries and products, is determined by a careful analysis of the underlying data included under each; of their trustworthiness as to source, of their general representativeness with respect to the group which the component series are designated to portray; of the extent to which they measure the changes in industries of the same group for which data are wanting; of the degree of accuracy with which they register the respective movements of the industries and of the products which they are especially designed to represent.

Weight factors may now be computed by dividing the value added figures assigned to a series for a given year by the respective quantity figures for the same year.[1]

It should be pointed out that an index of production based on weights derived from value added figures of a given year will register accurately the physical volume of production for a series of dates only on the assumption that there is throughout the period covered, no shift in the demand for the products and no change in the degree of elaboration in the various industries included in the index. An examination of our underlying data shows that there have been marked shifts in the demand for certain goods, or what is the same thing, in the relative importance of certain industries. As various industries and products change in relative importance in the course of time, so do the corresponding value added data, but while the value added and the correlative industry may usually vary together, they may not vary relatively in the same direction. Thus an industry and the related value added may decline together but the value added per unit of product may actually be increasing, or vice versa, they may rise together but the value added to each unit of product may be falling. If rising value added per unit could be taken as an indication of increasing elaboration and declining value added per unit as decreasing fabrication,[1] then surely these changes should be considered as important elements in the productive process as are those in the physical quantities.

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[1] This method of deriving weight factors for a production index was employed by the Federal Reserve Board in 1927. For an illustration of the process, see *Federal Reserve Bulletin*, March, 1927, Vol. XIII, p. 174.

During the period of years covered by our indexes, 1919 to 1929, the biennial Census of Manufactures has published five reports, showing figures of "value added by manufacture" for the census years 1919, 1921, 1923, 1925 and 1927. Analysis of the data discloses the fact that those of 1919, 1923, 1925 and 1927 are suitable for weighting purposes. The year 1921 experienced such a severe depression that both its quantity and value added figures are considered, because of their abnormal behavior, inappropriate as a basis for the computation of weights. In accordance with the procedure already described, the value added figures are allocated among the groups, industries and series, and four sets of weight factors are computed. The greatest changes in the weight factors appear, as may be expected, between the census years 1919 and 1923, during which period the value added per unit rose unprecedentedly in some industries and dropped precipitately in others. As between the census years 1923, 1925 and 1927, the changes in the weight factors are relatively less marked, but are nevertheless too important to be overlooked.

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[1] A declining industry with a rising value added per unit of production may not signify higher manufacture of basic materials; it may merely reflect the fact that the industry is one which has been obeying the law of increasing returns, but which, because of a severe fall in the demand for its products has actually augmented its cost of production relative to the degree of fabrication. On the other hand, a rising industry accompanied by a declining value added per unit of production need not denote decreasing fabrication; it may be that as a result of the increasing use of machinery and labor saving devices, the cost of manufacturing is really lowered, while at the same time the quality of the product is actually improved. The motor car industry is a case in point. The quality of automobiles has steadily been improved, but the value added to each car relative to its quality has been considerably lowered.

This latter observation brings into view an interesting point regarding the effect of the change in efficiency of one industry as compared with another on a production index whose weights are based upon value added data. An index weighted by value added will not depart from the underlying aggregate of physical quantities so long as the period for which the index is constructed is a fairly short and stable one, in which there has been no radical change in the efficiency of one industry as compared with the others. Where, with the passage of time, great changes have occurred in an industry, the value added per unit of production in an early period is no longer comparable to that of a later period after the changes have taken place, for the latter represents the output of more utilities per unit of value than the former. When fundamental shifts in efficiency have arisen in some industries and not in others, or have arisen to a greater extent in some than in others, when the productive contribution in terms of utilities as measured by value added per unit of production would be greater per value unit in those industries in which changes in efficiency have occurred, or have occurred at a relatively more rapid rate as compared with those industries whose efficiency has remained constant or has changed at a relatively slower rate, then value added no longer measures the relative productive contribution of the several industries, at least, the value added as a measure of the output of utilities of the several industries at one period is no longer comparable with that of another period in which the shifts in efficiency have eventuated. The bearing of this analysis is clear. In a period in which violent shifts in efficiency among the industries have occurred, a variable system of weights, while it may correct the shifts in the relative importance of the component industries in the index, is not a satisfactory remedy for shifts in their relative efficiency. Comparisons, therefore, of the successive magnitudes of the production index must necessarily be uncertain in such a case.

To test the effects of the different sets of weights, four annual indexes of producers' goods, of consumers' goods and of manufactures (the latter being a combination of the other two) are computed by using the four sets of weight factors. The results for the production of manufactures are presented in Table I. It is interesting to note that the greatest variations occur in the initial and terminal years. In 1919 they vary from 83 with 1919 weights to 87 with 1925 weights, and in 1929 from 121 with 1919 weights to 118 with 1927 weights. Moreover, the greatest differences in the indexes are found to be between 1919 weights and the other more recent sets of weights. The dissimilarities in the indexes obtained from the 1923, 1925 and 1927 weights are relatively less pronounced, but it should be observed that beginning in 1925 the three indexes commence to spread apart, with the 1923 and 1925 weights consistently above the 1927. The effect of the different systems of weights on our index may thus be summarized: The use of weights derived from data of a date more remote from the present has the tendency of an upward "bias" toward the terminal of the period, or what is the same thing, the use of weights computed from data of a date less removed from the present has the effect of a downward "bias" toward the end of the period. It is interesting to note that so far as the base period, 1923–1925, is concerned, the differences between the indexes are so slight that it does not matter what system of weights is

TABLE I

ANNUAL INDEXES OF THE VOLUME OF MANUFACTURES

1923–1925=100

Year	Computed from					
	1919 Weights (1)	1923 Weights (2)	1925 Weights (3)	1927 Weights (4)	1923–1925–1927 Weights (5)	Geometric average of indexes computed from 1923, 1925, 1927 weights (Cols. 2, 3 and 4) (6)
1919	83.4	86.4	87.2	85.5	86.2	86.4
1920	86.8	88.8	89.4	88.6	88.9	88.9
1921	65.3	67.6	68.1	67.1	67.5	67.6
1922	85.9	87.3	87.5	87.2	87.3	87.3
1923	100.7	100.9	101.1	101.4	101.1	101.1
1924	93.9	94.2	94.3	94.2	94.2	94.2
1925	105.3	105.0	104.6	104.4	104.7	104.7
1926	108.8	108.3	107.8	107.4	107.8	107.8
1927	106.3	106.6	105.9	105.1	105.8	105.9
1928	112.9	112.1	111.6	110.8	111.5	111.5
1929	120.9	119.1	118.7	117.7	118.5	118.5

used. The close agreement between the indexes at the base period and between those immediately preceding and following it, must largely be ascribed to the characteristic of the base to diminish the dispersion between the individual series of the respective indexes. In general these several observations made from a comparison of the indexes of manufactures apply to the indexes of producers' goods and of consumers' goods.

The differences in the indexes, resulting from the employment of different sets of weights, illustrate the necessity of adjusting the weights so as to secure results which will be more representative throughout the entire period. The relatively narrow range, within which the annual indexes computed with 1923, 1925 and 1927 weights vary, suggests the averaging of these three systems of weights to obtain a new set of weight factors. This, of course, permits us to retain the use of the aggregative formula. As pointed out by Professor Persons, the best index number of quantities for an intercomparison of three or more periods is given by this method.[1] To obviate the necessity of averaging averages, it is deemed more feasible to derive the new weight factors by aggregating the value added assigned to each series for 1923, 1925 and 1927, and then dividing this aggregate by the aggregate of the respective quantities for the three years. In columns 5 and 6 of Table I an annual index of manufactures, constructed with the new set of weight factors, together with a similar index obtained by taking the geometric average of the three indexes computed separately with weight factors of 1923, 1925 and 1927, is presented. It will be seen that the two are practically identical. The wide divergence between the indexes constructed with 1919 census data and those computed from 1923–1925–1927 census data, observed at the beginning and at the end of the interval, makes evident the fact that, if the later indexes may be taken to be more typical of the recent years, then surely they are not strictly typical of the earlier years. Some compromise must be effected which will make the indexes constructed with 1923–1925–1927 weights more representative of the earlier as well as the more recent years. The method adopted is the geometric average of each two sets of index numbers of those earlier overlapping years, in which the divergence occurs.[2] A study of the basic data of that period discloses the fact that for producers' goods and for manufactures, the

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[1] W. M. Persons, "The Effect of Correlation between Weights and Relatives in the Construction of Index Numbers," *Review of Economic Statistics*, May, 1928, Vol. X, p. 107.

[2] This method, with slight variation, was used by W. Thomas in constructing the index of the production of manufactures of the Federal Reserve Board and by Perry and Silverman in computing an index of the physical volume of Canadian Business. W. Thomas, "Construction of an Index Number of Production," this JOURNAL, September, 1927, Vol. XXII, p. 325; Perry and Silverman, this JOURNAL, June, 1929, Vol. XXIV, pp. 137ff.

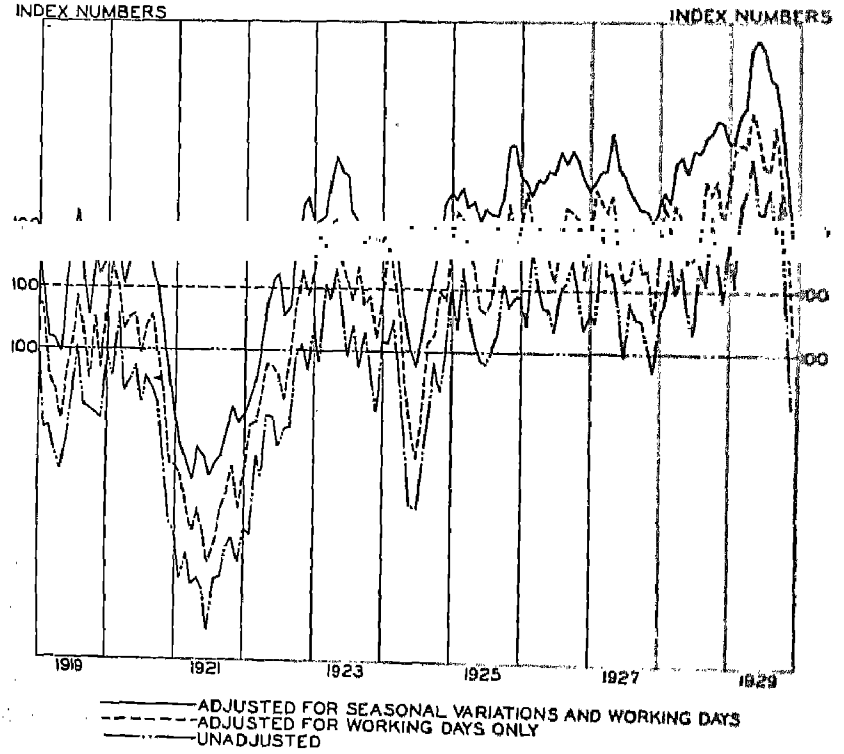
1919 weights going backward from 1921 are progressively more important than the 1923–1925–1927 weights, and for consumers' goods, the 1919 weights and the 1923–1925–1927 weights are considered to be of equal importance from 1919 to 1922. Accordingly, for producers' goods and manufactures, the index numbers with 1919 weights are taken in 1919 as thrice as, in 1920 as twice as, and in 1921 as equally important as those with 1923–1925–1927 weights; for consumers' goods, the simple geometric average of the two sets of index numbers is computed for the period, 1919–1922. For producers' goods and for manufactures from 1922 on, and for consumers' goods from 1923 on, only the 1923–1925–1927 weight factors are employed. This in brief, is the system of weights which is finally adopted for the computation of the monthly indexes.

The period 1923–1925 is selected as the base for comparison. The choice is made because of the overwhelming tendency on the part of

CHART III

INDEX OF PRODUCERS' GOODS: ADJUSTED FOR SEASONAL VARIATIONS AND WORKING DAYS, ADJUSTED FOR WORKING DAYS ONLY AND UNADJUSTED

(Average, 1923-25 = 100)



statisticians to take this period as the base for their index numbers. For comparative purposes, it is deemed desirable to have a base common to a large number of economic measurements.

Next the computed index numbers are subject to a correction to express them on the basis of average output per working day. For this purpose we have constructed a set of corrective factors, representing the number of working days for a given month, with which to divide into the index number for that particular month.[1] To illustrate the effect of the adjustments for the number of working days, both the adjusted and unadjusted indexes of producers' goods are shown on Chart III. The bottom curve, representing the unadjusted index, reveals the influence of the varying number of working days in the different months by the more erratic character of its month-to-month movements. A comparison of the adjusted indexes of the production of manufactures and of consumers' goods with the respective unadjusted indexes yields similar results.

The several indexes when adjusted for the number of working days are further corrected for seasonal variations.[2] The top curve on Chart III shows the effect of the seasonal adjustment on the index of the production of producers' goods.

Finally the indexes are adjusted for trend.[3]

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[1] No attempt is made to correct each individual series for holidays To undertake such a task would entail an enormous amount of computation. Moreover, as the industries are located over wide areas, in which the uniform observance of holidays is unlikely, adjustments of individual industries become uncertain. In view of these considerations, we have constructed a set of generalized corrective factors for working days which exclude Sundays and certain holidays, among which are the following: January 1, February 22, Good Friday, May 30, July 4, Labor Day, Thanksgiving and Christmas. Independence Day, Labor Day, Thanksgiving and Christmas are allowed for as one day. January 1, February 22 and May 30 are counted as one day only when they fall on week days, and when they occur on Sundays, are taken as half day only. Good Friday is counted as half day.

[2] The following seasonal indexes used in adjusting the indexes are computed by the "ratio-to-trend" method:

Month	*Producers' goods*	*Consumers' goods*	*Manufactures*	*Consumers' goods excluding automobiles*
January	102.3	99.2	101.5	100.6
February	107.8	103.7	106.9	103.7
March	104.6	101.0	103.0	99.4
April	102.9	101.7	101.9	99.6
May	99.8	104.4	101.1	102.3
June	95.9	104.0	98.8	102.4
July	93.4	99.2	96.0	98.2
August	96.1	98.1	99.0	99.6
September	102.0	102.1	102.2	100.8
October	99.9	99.2	100.0	100.3
November	100.4	97.1	99.4	100.9
December	94.3	90.3	93.2	95.2

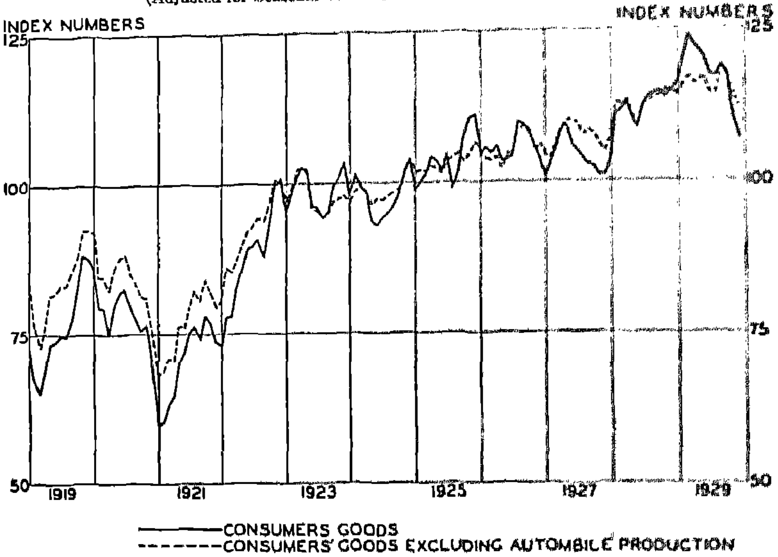
[3] The trend lines are based on the annual averages of the monthly indexes from January, 1919, to December, 1929, and are fitted by the method of least squares, with the origin at 1924. The equations are as follows:

Producers' goods: $y = 98.11 + 3.58x$
Consumers' goods: $y = 96.50 + 4.45x - .1055x^2$
Manufactures: $y = 97.12 + 3.91x$
Consumers' goods excluding automobile production: $y = 97.87 + 3.73x$

CHART IV

COMPARISON OF THE INDEX OF CONSUMERS' GOODS WITH THE INDEX OF CONSUMERS' GOODS EXCLUDING AUTOMOBILE PRODUCTION

(Adjusted for Seasonal Variations—Average, 1923–1925 = 100)



Because of the importance of automobile production as a composite in the index of consumers' goods and of the greater amplitude of its fluctuations as compared with the other component series, it is of interest to compute a separate index of consumers' goods from which the automobile series is excluded. As may be seen from Chart IV, the trend is altered somewhat, but though the magnitude of the variations is modified, particularly that of the more recent period when automobile production has become increasingly important, the timing of the variations remains substantially the same. This less inclusive index is also corrected for the number of working days, seasonal variations and trend.

Two sets of index numbers—one adjusted for the number of working days and seasonal variations and the other for the number of working days, seasonal variations and trend—of the physical volume of production of producers' goods, of consumers' goods, of manufactures and of consumers' goods excluding automobile production are presented in the appendix.

The monthly ordinates are obtained by straight-line interpolation.

The adjustment is made by dividing the index number for each month corrected for seasonal variation by the corresponding trend value. The final result is equal to:

$$\frac{\text{Index number per working day}}{\text{Trend} \times \text{seasonal index}}.$$

APPENDIX

INDEX OF PRODUCTION OF PRODUCERS' GOODS

(Adjusted for Seasonal Variations. 1923–1925 average=100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual average
1919	95.0	89.7	82.0	81.2	79.1	90.7	97.1	102.5	90.4	85.5	94.0	92.4	90.0
1920	94.8	96.4	95.4	90.0	95.3	99.7	95.8	97.7	93.1	80.5	82.3	75.7	92.2
1921	69.7	64.7	61.6	59.1	64.3	62.8	59.6	61.7	62.8	66.9	70.9	68.2	64.4
1922	69.6	72.1	75.0	80.6	87.7	91.1	92.2	85.5	87.1	97.1	102.4	104.8	87.1
1923	100.5	101.0	101.8	107.4	111.3	108.7	108.4	102.2	100.8	97.5	98.5	97.9	103.0
1924	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	91.8
1925	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	105.3
1926	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	109.1
1927	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	107.0
1928	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	111.2
1929	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	118.8

(Adjusted for Seasonal Variations and Trend. Normal=100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual average
1919	120.9	113.7	103.6	102.2	99.1	113.3	120.9	127.1	111.6	105.2	116.4	112.8	112.2
1920	115.4	116.9	115.3	109.0	114.3	119.2	114.1	116.0	110.1	105.5	96.6	88.7	110.1
1921	81.3	75.1	71.3	68.2	74.0	71.9	68.1	70.2	71.2	75.7	80.0	76.6	73.6
1922	77.0	80.4	83.4	90.2	98.0	100.4	101.9	93.5	95.0	105.5	111.0	113.1	95.6
1923	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	109.0
1924	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	93.5
1925	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	103.6
1926	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	103.6
1927	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98.4
1928	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98.9
1929	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	102.4

INDEX OF PRODUCTION OF CONSUMERS' GOODS

(Adjusted for Seasonal Variations. 1923–1925 Average=100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual average
1919	72.1	67.5	65.0	68.8	73.4	73.7	74.7	74.5	77.4	82.1	88.3	87.0	75.4
1920	85.9	79.4	79.4	75.0	79.9	82.0	82.6	79.4	77.5	75.5	70.4	71.2	78.7
1921	59.9	60.5	63.2	64.6	70.1	71.8	75.0	76.2	74.1	78.1	76.7	73.6	70.8
1922	79.0	77.6	78.0	82.9	85.5	89.1	90.6	90.7	97.8	93.2	99.8	101.0	87.3
1923	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98.8
1924	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	97.7
1925	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	103.7
1926	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	105.9
1927	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	104.1
1928	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	111.9
1929	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	117.6

(Adjusted for Seasonal Variations and Trend. Normal=100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual average
1919	104.2	97.0	92.0	97.6	103.4	103.1	103.8	103.0	106.3	112.0	119.7	118.1	105.1
1920	115.1	105.7	105.1	98.7	104.5	100.7	100.9	102.1	99.1	96.1	96.7	89.0	102.2
1921	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	91.1	87.0	85.3
1922	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	111.9	112.0	100.0
1923	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	107.4
1924	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	101.2
1925	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	102.8
1926	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100.8
1927	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	91.6	91.3	95.6
1928	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	99.7	100.6	99.3
1929	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	94.0	99.8	101.3

INDEX OF PRODUCTION OF MANUFACTURES

(Adjusted for Seasonal Variations. 1923–1925 Average = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual average
1919..........	86.2	81.3	76.2	77.1	77.0	83.9	87.8	92.7	85.6	83.7	92.1	89.9	84.4
1920..........	91.1	89.6	89.9	85.2	89.6	92.7	90.1	91.6	87.3	83.9	79.5	73.6	87.0
1921..........	66.0	63.0	62.2	61.3	66.8	66.3	65.1	67.7	67.0	70.7	72.8	69.8	66.6
1922.......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	87.8
1923.......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	101.3
1924.......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	94.1
1925.......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	104.7
1926.......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	107.8
1927.......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	105.9
1928.......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	111.4
1929.......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	118.3

(Adjusted for Seasonal Variations and Trend. Normal = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual average
1919......	[illegible]	[illegible]	[illegible]	100.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	108.8
1920......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	104.9
1921......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	77.9
1922......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98.2
1923......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	108.7
1924......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	96.8
1925......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	103.6
1926......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	102.7
1927......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	97.3
1928......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98.8
1929......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	101.4

INDEX OF PRODUCTION OF CONSUMERS' GOODS

(Excluding Automobile Production)

(Adjusted for Seasonal Variations. 1923–1925 Average = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual average
1919..........	83.8	76.6	72.9	76.2	81.6	81.9	83.1	83.2	85.5	87.9	92.5	92.6	83.1
1920..........	92.1	84.6	84.7	82.4	86.3	88.0	88.4	85.3	83.7	81.4	81.2	75.4	84.5
1921..........	68.3	68.6	70.7	70.1	76.2	76.0	79.5	82.1	80.5	84.1	81.9	79.4	76.4
1922..........	80.8	85.5	85.3	87.4	89.7	92.2	92.9	94.2	93.7	96.8	100.6	100.0	91.6
1923........	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98.0
1924........	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98.8
1925........	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	103.2
1926........	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	105.6
1927........	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	107.4
1928........	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	112.4
1929........	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	115.7

(Adjusted for Seasonal Variations and Trend. Normal = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual average
1919....	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	104.9
1920....	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	101.0
1921....	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	88.0
1922....	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	101.2
1923....	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	104.1
1924....	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100.9
1925....	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	101.6
1926....	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100.2
1927....	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98.5
1928..........	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	99.8	100.4	100.1	100.6	100.0	99.6
1929..........	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	97.7	101.1	100.3	96.7	95.1	99.3

DATA USED IN THE INDEX OF PRODUCERS' GOODS

Series	Assigned value added by manufacture in 1923–1925–1927 (in millions of dollars)	Percentage of individual item to total	Source
1. Mill consumption of raw cotton .	5,405	13.8	Bureau of the Census
2. " " " " wool . . .	2,620	6.7	Ditto
3. Deliveries of raw silk to mills	2,200	5.6	Silk Association of America
4. Pig iron production.	1,125	2.9	Iron age
5. Steel ingots production.	12,660	32.2	American Iron and Steel Institute
6. Lumber production	5,055	12.9	Bureau of the Census and estimates
7. [illegible]	700	1.8	Survey of Current Business
8. S[illegible]	285	.7	Bureau of the Census
9. Production of upper leather—cattle	180	.4	Ditto
10. [illegible]	200	.5	Ditto
11. [illegible] kid.	300	.8	Ditto
12. Newsprint production.	309	.8	Federal Trade Commission and Newsprint Service Bureau
13. Wrapping paper production.	444	1.1	Federal Trade Commission, American Paper and Pulp Association and Survey of Current Business
14. Paper board production.	584	1.5	Bureau of the Census
15. Mechanical pulp production.	43	.1	Federal Trade Commission, American Paper and Pulp Association, Survey of Current Business
16. Chemical pulp production.	135	.3	Ditto
17. Production of paper board shipping boxes.	385	1.0	Paperboard Industries Association and Survey of Current Business
18. Fuel oil production.	291	.7	Bureau of Mines
19. Lubricating oil production.	166	.4	Ditto
20. By-product coke production. . . .	1,045	2.7	Ditto
21. Beehive-coke production.	105	.3	Ditto
22. [illegible]	900	2.5	Ditto
23. [illegible]	640	1.6	Plate Glass Manufacturers of America
24. [illegible]	1,285	3.3	American Bureau of Metal Statistics
25. [illegible]	370	.9	Ditto
26. Slab zinc.	500	1.3	American Zinc Institute
27. Tin deliveries.	290	.7	New York Metal Exchange
28. Production of motor trucks.	440	1.1	Bureau of the Census
29. Shipment of locomotives by manufacturers.	110	.3	Ditto
30. Shipment of freight and passenger railway cars by manufacturers. .	285	.7	Interstate Commerce Commission
31. Vessels built.	145	.4	Bureau of Navigation

DATA USED IN THE INDEX OF CONSUMERS' GOODS

Series	Assigned value added by manufacture in 1923–1925–1927 (in millions of dollars)	Percentage of individual item to total	Source
1. Hogs slaughtered under federal inspection	1,942	8.3	Bureau of Animal Industry
2. Cattle slaughtered under federal inspection	1,226	5.2	Ditto
3. Calves slaughtered under federal inspection	137	.6	Ditto
4. Sheep slaughtered under federal inspection	125	.5	Ditto
5. [illegible]	1,440	6.1	Russell's Commercial News
6. [illegible]	70	.3	Rice Millers' Association
7. Meltings of raw sugar	800	3.4	Statistical Sugar Trade Journal
8. Butter production	757	3.2	Bureau of Agricultural Economics
9. Cheese production	152	.7	Ditto
10. Production of condensed and evaporated milk	291	1.2	Ditto
11. Production of ice cream	680	2.9	Ditto
12. Corn grindings	320	1.4	Associate Corn Products Manufacturers
13. Production of oleomargarine	90	.4	Bureau of Internal Revenue
14. Percentage of carpet and rug loom hours active	645	2.7	Bureau of the Census
15. Production of underwear	1,005	4.3	Ditto
16. Shipment of enameled sanitary wares	505	2.1	Ditto
17. [illegible]	1,365	5.8	Ditto
18. [illegible]	1,065	4.5	Rubber Association of America
19. Inner tube production	180	.8	Ditto
20. Newsprint consumption	2,442	10.4	Federal Trade Commission and American Newspaper Publishers' Association
21. [illegible]	2,004	8.5	Ditto, and Survey of Current Business
22. [illegible]	1,194	5.1	Ditto
23. [illegible]	701	3.0	Bureau of Mines
24. [illegible]	102	.4	Ditto
25. [illegible]	270	1.2	Bureau of the Census
26. [illegible]	485	2.1	Bureau of Internal Revenue
27. Cigars—	290	1.2	Ditto
28. Chewing, smoking and snuff "	150	.6	Ditto
29. Passenger automobile production	3,070	13.1	Bureau of the Census

THE INADEQUACY OF CENSUS DATA FOR INDIVIDUAL INDUSTRIES

By Glenn E. McLaughlin, *Bureau of Business Research, University of Pittsburgh*

The United States Bureau of the Census is prohibited by law from publishing any statistics which may disclose even approximately the data supplied by individual establishments. This restriction compels the Bureau to combine in one item data for those industries which report only one or two plants or which are dominated by one or two corporations. Such combined items represent a complete loss in detail to the research student who is interested in the relative importance of different industries. The Bureau seldom finds it necessary to use such items in publishing data by industries for the United States as a whole but in presenting data for cities having 100,000 inhabitants or more a large number of industries are usually lumped together as "all other industries." For each of these industries no separate data are given relative to number of establishments, wage earners, wages, or value of products; for that matter, no list of the specific industries included in the combined item is published in any but decennial censuses.[1] The Bureau warns the research student that such items often include industries which are more important than some of those shown separately.

According to the practice of the Bureau of the Census, separate data for an industry—whether in a city, a state, or the United States—may not be published under the following circumstances: (1) when the industry contains less than three firms, (2) when one establishment or corporation produces 75 per cent of the total value of products, (3) when two establishments or corporations produce 90 per cent of the total value of products. Furthermore, (4) separate data for an industry *in a city* cannot be published, regardless of the number of establishments, when there are only one or two establishments or corporations, or only one dominating establishment or corporation, operating in the remainder of the state. In such cases only the state figures are published.

Of the four cases the first is by far the most common. All cities and indeed all states contain industries with only one or two establishments. For example, no data can be obtained for the shipbuilding industry in Philadelphia in 1919, 1921, or 1927 owing to the small number of plants. Data for the locomotive industry in New York State have not been available for several censuses. Occasionally these industries with less than three establishments rank among the most important. The shipbuilding industry ranked high in Philadelphia in 1919.

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[1] Lists of such industries for both states and cities were published for the biennial census of 1921.

The second case is not frequent, though it may result in withholding data for a few outstanding industries. Thus no data are given for steam-railroad repair shops in Connecticut, although in 1927 there were twelve establishments in this industry. No doubt this is due to the fact that 75 per cent of the activity is confined to shops of the New York, New Haven, and Hartford Railroad. Although there are more than three plants producing agricultural implements in Chicago and more than three producing aluminum manufactures in Pennsylvania, no data are available for either. Because of the varying importance of the largest establishment, it may be possible to present data for an industry in one year, but impossible in another. For example, in 1921 no data are available for the production of corn sirup, corn oil, and starch in Illinois whereas in 1927 data are given. In each year the industry included four establishments.

The third case is difficult to identify. Probably owing to the great relative importance of two corporations, data on the soap industry in Wisconsin are lacking in recent censuses; about ten plants have been in operation.

Although it is not a general restriction, several examples can be given of the fourth case, i.e., the impossibility of publishing data for an industry in a city because of the small number of establishments in the rest of the state. Chicago in particular has been affected. For that city it has usually been impossible to publish data for a number of industries owing to the fact that each included only two establishments in Illinois outside of Chicago. An example is the electroplating industry with 42 establishments in the city and 44 in the state. A comparable situation rarely precludes the publication of state figures. Yet in 1921 it was impossible to present Louisiana totals for the cane sugar industry, excluding the products of refineries, even though only two of the 134 establishments were located outside of that state. By 1927 it was possible to give the data for Louisiana since all of the 53 establishments then in operation were in that state.

In the summary for each industry it is often necessary that the data for several states be combined in an "other states" item. Because of the danger of disclosing data for individual establishments this combined item may include statistics for several states representing a sizable percentage of the total activity in an industry. For the cement industry in 1927, this item contains 36.5 per cent of all the wage earners in the industry. These were employed in 66 establishments scattered as follows: Alabama 7, Colorado 3, Florida 1, Georgia 3, Illinois 5, Indiana 5, Kentucky 1, Louisiana 1, Maryland 2, Minnesota 3, Montana 2, Nebraska 1, New Jersey 2, Ohio 11, Oklahoma 2, Oregon 3, South Dakota 1, Utah 3, Virginia 2, Washington 4, West Virginia 3, Wisconsin 1.

TABLE I

PER CENT OF THE TOTAL NUMBER OF WAGE EARNERS FOR EACH OF SIXTY SELECTED INDUSTRIES REPORTED UNDER THE "OTHER STATES" CLASSIFICATION, UNITED STATES, 1927

	Per Cent		*Per Cent*
Agricultural implements	3.0	Knit goods	3.1
Artificial leather	52.0	Lard substitutes	52.8
Blast furnaces	6.6	Locomotives	100.0
Boots and shoes, not rubber	1.5	Lumber and timber products	0.1
Boots and shoes, rubber	55.0	Motor cycles, bicycles, and parts	46.6
Bread and bakery products	0.0	Motor vehicle bodies and parts	0.1
Canning and preserving: Vegetables, etc.	0.6	Motor vehicles	4.2
Car and general construction and repairs, steam railroad repair shops	1.3	Paper	1.7
Carpets and rugs, rag	37.8	Pens, steel and brass	100.0
Carpets and rugs, wool, not rag	11.1	Petroleum refining	10.6
Cars, electric and steam railroad	19.7	Plumbers' supplies	29.6
Cast-iron pipe	17.9	Pottery	4.9
Cement	36.5	Printing and publishing	0.0
Chemicals	6.5	Rubber goods other than shoes, tires and tubes	20.5
Cigars and cigarettes	5.9	Rubber tires and inner tubes	18.4
Clothing, men's, except work clothing	0.7	Sand-lime brick	62.9
Clothing, women's	0.7	Ship and boat building	5.2
Collars, men's	6.3	Silk manufactures	5.4
Cotton goods	0.8	Slaughtering and meat packing	3.8
Cutlery and edge tools	8.9	Smelting and refining, copper	56.0
Electrical machinery	0.8	Smelting and refining, lead	70.7
Flax and hemp, dressed	42.8	Soap	22.7
Food preparations	10.4	Steel works and rolling mills	8.8
Forgings, iron and steel	1.8	Structural and ornamental iron and steel work	0.8
Foundry and machine shop products	0.0	Sugar, beet	63.5
Gas and electric fixtures	7.9	Sugar refining, cane	40.8
Glass	6.5	Textile machinery	7.7
Gloves and mittens, leather	9.8	Whips	100.0
Graphite, ground and refined	100.0	Woolen goods	2.4
Grindstones	5.8	Worsted goods	6.7

As a rule the loss in detail is not as great as it was in the cement industry in 1927. This is clear from the percentages for 60 selected industries presented in Table I. The loss in detail tends to vary with the size of the industry. The large industries show little loss in detail whereas some of the smallest show no detail at all. But this is by no means a complete relationship. A great deal depends on whether the industry is concentrated in a few states. There is practically no loss in data for those industries which are distributed over the country in proportion to the population — generally industries which rank high for the country as a whole. No loss occurs, for instance, in the printing or in the baking industries. The loss in detail is much greater in many of the industries characterized by large scale production, as in the rubber industry, in smelting and refining, and in many branches of the steel industry. In highly concentrated industries, data may be quite com-

$160,000 and 400 tons of hammered steel, valued at $112,000; total, 1,200 tons, worth $272,000. The materials consumed in the production of this amount were 1,300 tons of bar-iron, costing $84,000; 6,000 tons of coal, worth $27,000; and other materials valued at $23,000; a total of $134,000."

Detailed statistics are not now published by the Bureau of the Census because of legal restrictions forbidding the publication of any data which might reveal even approximately the data supplied by individual plants or corporations. All answers to census questionnaires must be "held in strict confidence." Presumably the purpose of this secrecy is to keep even the approximate figures of a corporation from the inquiring eyes of a competitor. But of all individuals the competitor is the most likely to know these figures. He does not need census data in order to reach a fairly accurate estimate of another producer's employment or production. It may be that several producers through trade associations or informal conferences are exchanging this information, perhaps even on a monthly, instead of a biennial, basis. In any event it is quite likely that present restrictions placed upon the Bureau of the Census handicap the research student more than they insure the secrecy of production figures.

Such generally known data as the number of wage earners might well be published biennially for each industry regardless of the number of plants without seriously violating the secrecy of an individual plant's operation, especially when it is noted that census data for states or cities have so far not been published until the second year after the period covered. The remaining data—wages, costs of materials, and value of production—might properly be made available to the interested research student or economic historian after a period of, say, ten years. Surely by that time the figures have lost their competitive significance.

Yet even present restrictions do not prohibit the publication of tables listing the industries represented in the "all other" group together with the number of plants in each; these tables are given in decennial censuses. They were also published in the biennial census of 1921. Nor do legal restrictions preclude the publication of tables showing the location and number of establishments by counties. Paul W. Stewart of the Department of Commerce included this material for 1927 in his *Market Data Handbook of the United States*.

Of the remaining categories of data the least secret is probably the average number of wage earners. Locally the employment of a plant may be accurately known; though if the plant be one of two in the industry or the dominating one of several it is impossible to tell from the most complete statistics now published by the Bureau whether the industry represented is of great or little importance. Some states publish directories giving employment figures of all manufacturing establishments. Such is the case in Pennsylvania where the directory classifies firms according to industry and according to city and county, so that it is possible to determine the relative importance of any industry in any city or county. The average number of wage earners employed in a given plant or by a given corporation has not been considered confidential information. Indeed, prior to 1922 Pennsylvania published complete industrial statistics—including data on wages, value of product, and so forth—for each industry represented in a city or county regardless of the number of establishments.

Below are given, in the order of desirability, alternative suggestions for increasing the adequacy of census data. First is listed the initial publication of complete data; the other suggestions are substitutes for the first, each calling for less and less additional data until the last suggestion which calls for the release after a period of years of data covering the number of wage earners in every industry. (The Bureau of the Census at the present time will release detailed data for industrial *groups*, at least in the case of states and large cities.) It is desirable, however, that additions to census data be made gradually. If the Bureau of the Census is successful in securing the coöperation of manufacturers in collecting and presenting data for the number of wage earners in the individual industries represented in each state and in each city, the presentation of more complete data might well be considered. The following suggestions apply to data for the United States, for individual states, and for individual cities:

1. Original publication of detailed data for every industry, i.e., data covering number of establishments, number of wage earners, wages, cost of materials, value of products, and, for bulk products, quantities. From value of products and cost of materials the value added by manufacture can be calculated.
2. Original publication of data covering the number of wage earners and value added by manufacture in every industry and the release after a period of years of the remaining data.
3. Original publication of data covering the number of wage earners in every industry and the release after a period of years of the remaining data.
4. Original publication of detailed data for every industrial group (foods, textiles, etc.) and the release after a period of years of detailed data for every industry.
5. The release after a period of years of detailed data for every industry.

6. The release after a period of years of data covering the number of wage earners in every industry.

At present it is probably impossible to secure legal authorization[1] for the publication of wage or production statistics for industries regardless of the number of plants. On the other hand, the chance of securing permission to publish figures for the average number of wage earners for each industry is undoubtedly greater. The number of wage earners in most cases gives a reasonably accurate indication of the relative importance of an industry. Even if legal permission to publish these data is obtained, it may be urged that the expense of compiling and publishing the data would be great. As a matter of fact the Bureau of the Census at present makes such calculations and the space for publication would require not more than 50 additional pages in the present biennial volume of 1500 pages. Perhaps the data could be placed in footnotes. It is believed that the desirability of this material is well worth the expense which its presentation would entail.

It must be added that two important changes are being made in the Census of Manufactures for 1929: in the first place primary emphasis is being placed on the presentation of data for industrial regions—corresponding data for the major city being given only when it is possible to release both—and in the second place the "all other industries" figures are being broken down into figures for industrial groups or combinations of groups when necessary.[2] The first change will allow the publication of figures for an industry where there are enough establishments in the city and immediately outside to make up industrial totals which reveal the identity of no separate establishment, provided that the figures for the area and those for the state do not reveal the identity of establishments in the remainder of the state. There will remain, however, in most regions industries, often of major size, for which no data can be given because of the small number of establishments or because of the dominating importance of one or two. The second change will result in the publication of data very valuable in the analysis of the industrial structure of a city or region, but in any given instance an industrial group may include many particular industries and perhaps several of major importance. For the thorough analysis of the manufacturing activity of a region or a city it still remains necessary to secure some indication of the relative importance of each industry.

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[1] In the opinion of the officials in the Bureau of the Census to whom this article by Mr. McLaughlin was referred, it would be impracticable to put into effect any of the six suggestions specified in his paper, with the possible exception of No. 6 and the first part of No. 3; and even that it is believed could not be done without securing legal authorization and the consent of the manufacturers concerned.—Ed.

[2] The Bureau will discontinue publishing statistics by industries for a region unless separate figures for the leading industry can be published or unless those industries for which figures can be presented account for at least 50 per cent of the total number of wage earners.

ECONOMIC FACTORS IN NEGRO MIGRATION

By Edward E. Lewis, *Howard University*

Among the causes of the recent movement of Negroes from southern farms to the industrial centers of the country, are two of an economic character, namely, the demand for labor on the part of industry, and the recent agricultural disorganization in the Cotton Belt. A straightforward statistical analysis of the "industrial" and "agricultural" factors in Negro migration would involve the correlation of an index of migration (from the various counties of the Cotton Belt) with indexes of the two underlying factors.[1] Such a procedure cannot be followed, however, because it is impossible to measure directly the strength of industrial labor demand or the repulsive force of agricultural depression.[2] It is necessary, therefore, to proceed by indirection.

While there is no quantitative information concerning the causal factors in which we are interested, extensive data are available concerning three distinct phenomena into which these factors enter, namely, Negro migration, white migration, and changes in the amount of cotton cultivated in the various parts of the Cotton Belt.[3] (This third phenomenon is affected not only by the profitableness of agriculture, that is, by the agricultural factor, but also by the industrial factor, causing shortage or abundance of agricultural workers.) It is by a study of these three "resultant" phenomena that the importance of the underlying factors in one of them—Negro migration—is estimated.

The relations obtaining among the two underlying factors and the three resultant phenomena may be expressed in terms of mathematical symbols. Let A and I represent the agricultural and industrial factors respectively, and let N, W, and C represent our indexes of Negro migration, white migration, and changes in the amount of cotton cultivated. Let each one of these series be expressed in terms of its standard deviation, and as deviations from its mean. Let us assume that the agricultural and industrial factors are independent of each other,[1] that is, that $r_{AI}=0$. Then we may write

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[1] For a discussion of the problems raised by the utilization of these rather broad sets of conditions as single factors, see E. E. Lewis, *The Mobility of the Negro*, pp. 13–16.

[2] For the most part, during the period studied, agricultural conditions were such as to cause migration out of rural territory. It is necessary to recognize, however, that in some instances relatively favorable agricultural conditions attracted Negroes back to the farm. In other words the agricultural factor must be interpreted as having both positive and negative values. The same interpretation is necessary for the industrial factor, that is, as drawing Negroes into industry, or through urban unemployment forcing them back to the country.

[3] The three sets of information consist of percentage changes from 1919 to 1924, in the number of colored farmers (figures for the total agricultural population are not available, but the "farmers," because they include "croppers" and therefore a large proportion of all agricultural workers, give an adequate index of the total agricultural population), percentage changes in the number of white farmers, and percentage changes in the cotton acreage harvested. The analysis is confined to the five year period from 1919 to 1924 for the following reasons. In the first place, the requisite data are available for these years in the United States Censuses of Agriculture. In the second place, the most striking migration of the post-war period occurred during those years. Finally, both the agricultural and the industrial factors were operative. This relatively short period therefore constitutes a "sample" of Negro migration well suited to an analysis of its economic causes.

$$(1) \quad N=r_{NA}A+r_{NI}I+e_N$$

as the regression equation[2] by which N may be estimated from A and I, together with the term e_N, representing the error involved in making such estimates. The two correlation coefficients, r_{NA} and r_{NI}, are the measures of the associations in which we are interested. It is the specific purpose of the analysis to evaluate these constants.

Corresponding to equation (1), are two others connecting the agricultural and industrial factors with white migration and with changes in the amount of cotton cultivated.

$$(2) \quad W=r_{WA}A+r_{WI}I+e_W$$
$$(3) \quad C=r_{CA}A+r_{CI}I+e_C.$$

Let us multiply equations (1) and (2), term by term.

$$\begin{aligned}(4) \quad NW=&r_{NA}r_{WA}A^2+r_{NI}r_{WI}I^2\\ &+(r_{NA}r_{WI}+r_{NI}r_{WA})AI\\ &+(r_{NA}A+r_{NI}I)e_W\\ &+(r_{WA}A+r_{WI}I)e_N\\ &+e_We_N.\end{aligned}$$

Let us sum equation (4) and divide by the number of counties. Since A and I are assumed to be uncorrelated, $\Sigma AI=0$ (these variables being measured from their respective means). The third term therefore drops out. It is easy to show that e_N and e_W are both uncorrelated with A and I.[3] The fourth and fifth terms of equation (4) are therefore each equal to zero. It may be assumed that e_N and e_W are not appreciably correlated with each other, since they represent population movements of the two races arising from the large number of non-agricultural and non-industrial causes. Hence the last term of equation (4) will drop out in the process of summation. With respect to the two first terms on the right of the equal sign, it should be noted that $\Sigma\frac{A^2}{n}$ and $\Sigma\frac{I^2}{n}$ are both equal to unity. On the left of the equal sign, $\Sigma\frac{NW}{n}$ is equal to r_{NW} since these variables have means equal to zero and standard deviations equal to unity. Hence, in summing equation (4) and dividing by the number of counties, we get

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[1] This assumption seems to be fully justified by the facts of the case. An association between industrial labor demand and agricultural conditions would arise if labor agents sought out the regions of unusually depressed agriculture for their recruiting activities. Such may have been the case, taking the Cotton Belt as a whole. But the analysis in this article is confined to the counties of South Carolina and Georgia. Throughout this region, agriculture was hard hit, and it was presumably impossible for labor agents to discriminate to any appreciable degree among the various counties.

[2] The two regression coefficients in equation (1), $b_{NA\cdot I}$ and $b_{NI\cdot A}$, reduce respectively to r_{NA} and r_{NI}, because $r_{AI}=0$ and the three standard deviations are each equal to unity. This may be shown by substituting in the ordinary formula for the partial regression coefficient. See G. U. Yule, *An Introduction to the Theory of Statistics*, eighth ed., p. 238.

[3] For example, $\Sigma e_NA=\Sigma NA-r_{NA}\Sigma A^2-r_{NI}\Sigma AI$; or, $\Sigma e_NA=nr_{NA}-nr_{NA}=0$.

$$(5) \quad r_{NW} = r_{NA}r_{WA} + r_{NI}r_{WI}.$$

Similarly, by multiplying equations (1) and (3), and equations (2) and (3), summing, and dividing by the number of counties, we have

$$(6) \quad r_{CN} = r_{NA}r_{CA} + r_{NI}r_{CI}$$
$$(7) \quad r_{CW} = r_{CA}r_{WA} + r_{CI}r_{WI}.$$

The quantities on the left of the equal signs in the three foregoing equations are given by the available data. On the right of the equal signs are six unknowns, r_{CA}, r_{CI}, r_{WA}, r_{WI}, r_{NA}, and r_{NI}. While we are interested only in the two last unknowns, it is necessary to eliminate the other four in order to evaluate the two last. Hence, we need six equations among the six unknowns, three more than we now have.

The industrial factor affects cotton acreage only as it affects the number of persons available to cultivate the cotton. In terms of partial correlation, then, we may put,

$$(8) \quad r_{CI \cdot NW} = 0.$$

It follows that

$$(9) \quad \frac{r_{CI \cdot N} - r_{CW \cdot N}r_{WI \cdot N}}{\sqrt{1 - r^2_{CW \cdot N}}\sqrt{1 - r^2_{WI \cdot N}}} = 0.$$

Whence,

$$(10) \quad r_{CI \cdot N} = r_{CW \cdot N}r_{WI \cdot N}.$$

Substituting for the partial coefficients in this equation, and cancelling, we get one more equation, namely

$$(11) \quad r_{CI} = Rr_{NI} + Sr_{WI}$$

in which

$$(12) \quad S = \frac{r_{CW} - r_{CN}r_{WN}}{1 - r^2_{WN}}$$

and

$$(13) \quad R = r_{CN} - Sr_{WN}.$$

It is also approximately true that the industrial factor had no effect upon cotton acreage if changes in the white population tended to counterbalance changes in the colored population. (It would be strictly true if the average cotton acreage of white farmers were exactly equal to the average cotton acreage of colored farmers, this average being the same in 1919 and 1924.) Let T be equal to the percentage change in the total number of farmers, this being an index of the change in total population. Then, we may put

$$(14)\quad r_{CI\cdot T}=0$$

or

$$(15)\quad r_{CI}=r_{CT}r_{TI}$$

provided neither r_{CT} or r_{TI} is equal to unity. On the right of the equal sign, the first factor, r_{CT}, may be obtained from the available data, and the problem at hand is to evaluate r_{TI}.

If p is the proportion of colored farmers in 1919 and q $(=1-p)$ is the proportion of white farmers, then it is easy to show that in the original units[1]

$$(16)\quad T=pN+qW.$$

Multiplying equation (16) by I, summing, and putting σ_I equal to unity, we get

$$(17)\quad nr_{TI}\sigma_T=\Sigma IpN+\Sigma IqW$$

in which n is the number of counties. The problem now is to evaluate the two triple product-sums on the right of the equal sign. This may be done as follows.

$$(18)\quad \Sigma IpN=n\sigma_{(pN)}r_{I(pN)}$$

The two factors on the right of the equal sign are approximately equal to the following expressions:[2]

$$(19)\quad \sigma_{(pN)}=\bar{p}\bar{N}\sqrt{V^2{}_p+V^2{}_N+2V_pV_Nr_{pN}}$$

$$(20)\quad r_{I(pN)}=\frac{V_pr_{pI}+V_Nr_{NI}}{\sqrt{V^2{}_p+V^2{}_N+2V_pV_Nr_{pN}}}$$

---

[1] Let the subscript 0 denote the absolute number in 1919 and the subscript 1, the absolute number in 1924. For the moment, let T, N and W be proportionate changes, that is, percentage changes divided by 100 per cent. Then, $T=\frac{N_1+W_1}{N_0+W_0}-1.$

$$\text{Or, } T=\frac{N_1}{N_0+W_0}+\frac{W_1}{N_0+W_0}-1.\quad \text{Now, } \frac{N_1}{N_0+W_0}=\frac{N_1}{N_0}\cdot\frac{N_0}{N_0+W_0}=(N+1)p.$$

Similarly, $\frac{W_1}{N_0+W_0}=(W+1)q.$ And since $p+q=1$, $T=Np+p+Wq+q-1=Np+Wq.$ Multiplying through by 100 per cent, we get the same equation in percentage terms.

[2] E. J. Gumbel, "Spurious Correlation and Its Significance to Physiology," this JOURNAL, June, 1926, pp. 181, 187.

in which V is equal to the standard deviation divided by the mean, and $\bar{p}$ and $\bar{N}$ are the means of the respective series.

Multiplying equations (19) and (20), and substituting in equation (18), we have,

$$(21) \quad \Sigma IpN = n\bar{p}\bar{N}(V_p r_{pI} + V_N r_{NI}).$$

We may assume that r_{pI} is of negligible value, and therefore drop out the first term, putting

$$(22) \quad \Sigma IpN = n\bar{p}\bar{N}V_N r_{NI} = n\bar{p}\sigma_N r_{NI}.$$

Similarly, since $r_{qI}=0$, if $r_{pI}=0$, we may put

$$(23) \quad \Sigma IqW = n\bar{q}\sigma_W r_{WI}.$$

Substituting equations (22) and (23) in equation (17), and dividing by n, we get

$$(24) \quad \sigma_T r_{TI} = \bar{p} r_{NI} \sigma_N + \bar{q} r_{WI} \sigma_W.$$

Substituting equation (24) in equation (15), we have

$$(25) \quad r_{CI} = E r_{NI} + F r_{WI}$$

in which

$$(26) \quad E = \frac{r_{CT}\bar{p}\sigma_N}{\sigma_T}$$

and

$$(27) \quad F = \frac{r_{CT}\bar{q}\sigma_W}{\sigma_T}.$$

It simplifies the mathematics somewhat if we convert equations (11) and (25) into two others, each containing only two of the three correlation coefficients involved. Let us put

$$(28) \quad r_{CI} = M r_{NI}$$

and

$$(29) \quad r_{WI} = L r_{NI}.$$

Solving equations (11) and (25), we get

$$(30) \quad M = \frac{ES - RF}{S - F}$$

and

$$(31) \quad L = \frac{E - R}{S - F}.$$

Let us take one more equation of the same form as equations (28) and (29)

$$(32) \quad r_{WA} = K r_{NA}.$$

The value of K will be discussed presently.

To solve for the six unknown correlation coefficients of the problem we now have six equations, namely, equations (5), (6), (7), (28), (29) and (32).

Substituting equations (28), (29) and (32) in equations (6) and (7), solving the resulting equations for $r_{CA}r_{NA}$, equating, and then solving for r^2_{NI}, we get

$$(33)\quad r^2_{NI}=\frac{Kr_{CN}-r_{CW}}{M(K-L)}.$$

Substituting equations (29) and (32) in equation (5), and solving for r^2_{NA}, we get

$$(34)\quad r^2_{NA}=\frac{r_{NW}-Lr^2_{NI}}{K}$$

in which the value of r^2_{NI} is already given by equation (33).

Equations (33) and (34) give us the values of the desired correlation coefficients in terms of constants all of which are given by the data except K. No equation has been found connecting the value of K with the known quantities of the problem. This deficiency, however, does not prevent us from reaching conclusions in the analysis, and in fact illustrates two very useful principles of procedure in connection with the mathematical method pursued here. The first of these is the approximate evaluation of constants from our general non-quantitative information concerning the problem at hand. The second principle consists of the selection of a whole range of probable values for a given constant rather than a single value. It is sometimes possible, as in the present case, to draw useful conclusions which hold for any value of the constant within such a range.

The amount of Negro migration arising from agricultural causes, in a given county, from 1919 to 1924, in percentage terms, is given by the expression[1]

$$(35)\quad \frac{\sigma_N r_{NA} A}{\sigma_A}.$$

Similarly, the amount of white migration in the same county, due to agricultural conditions, is given by

$$(36)\quad \frac{\sigma_W r_{WA} A}{\sigma_A}.$$

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[1] This expression is what the first term on the right of the equal sign in equation (1) becomes when N and A are expressed in their original units.

Putting the ratio of the second expression to the first equal to t, substituting Kr_{NA} for r_{WA}, cancelling, and solving for K, we get

$$(37) \quad K = \frac{\sigma_N}{\sigma_W} t$$

in which, to repeat, t is the ratio of the index of "agricultural" migration of whites to the index of "agricultural" migration of Negroes. Since σ_N and σ_W are given by the data, K may be evaluated if t is known.

The relative impact of agricultural conditions upon the white and Negro population depends largely upon their relative dependence upon the particular form of agriculture being practiced, their relative technical competence, and their relative financial resources. An examination of southern agricultural conditions from these three standpoints leads one to believe that the value of t lies somewhere between 0.5 and 1.0.[1] In the subsequent analysis, therefore, the value of K is taken to lie somewhere in the interval between the two points corresponding to these values of t.[2]

The analysis just set forth has been applied to a group of 72 counties in Georgia and South Carolina. In this section of the Cotton Belt, a substantial emigration of Negroes occurred during the period from 1919 to 1924. In this section also both the agricultural and the industrial factors were apparently very strong. The data applying to these 72 counties are presented in Table I. Table II contains the estimated coefficients of correlation found by applying equations (33) and (34) to the data of Table I. It will be seen that for both values of K, r_{NI} is very much greater than r_{NA}. It is easy to show[3] that if K has any value between the limits 0.87 and 1.73, the coefficients of correlation will lie between the corresponding values in Table II. But the chances

TABLE I

BASIC DATA DERIVED FROM 72 COUNTIES IN SOUTH CAROLINA AND GEORGIA

r_{CN}	0.77
r_{CW}	0.43
r_{NW}	0.49
r_{CT}	0.85
$\bar{p}$	0.54
σ_N	19
σ_W	11
σ_C	24
σ_T	14

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[1] See E. E. Lewis, *op. cit.* pp. 78ff for a full discussion of the point.

[2] Specifically, from equation (37) we get $K = 0.87$ and $K = 1.73$.

[3] By substitution from Table I, the expressions found in equations (33) and (34) may be written as functions of K alone. The first derivatives of these two functions have no real zeroes between $K = 0.87$ and $K = 1.73$. Hence the functions are monotonic between these values.

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TABLE II

COEFFICIENTS OF CORRELATION BETWEEN NEGRO MIGRATION, AND THE INDUSTRIAL AND AGRICULTURAL FACTORS, FOR TWO VALUES OF K

	$K = 0.87$	$K = 1.73$
r_{NI}	0.83	0.98
r_{NA}	0.32	0.11

are that the value of K did actually lie between the two limits chosen. Hence we are able to conclude that the coefficient r_{NI} was very much greater than the coefficient r_{NA}, in spite of the fact that the actual value of K is unknown. Furthermore, we have set relatively narrow limits to the values of these coefficients. The use of a range of values for a constant rather than any single value relieves the analysis of some rigidity with respect to its underlying assumptions. It is perhaps needless to point out, however, that the device will yield results only under very special circumstances.

The method by which these results have been obtained requires some discussion. The general procedure may be characterized as "mathematical" rather than as strictly "statistical." It consists of a symbolic formulation of the relationships obtaining among the several elements of the problem; such a formulation constituting a theoretical framework by means of which the data may be viewed in correct perspective. The mathematical manipulation of these symbolic statements of the problem brings to light the quantitative relations implicit in the data. In the present paper, the relative importance of the underlying factors is found through mathematical analysis, to be revealed by the measures of the associations (e.g. r_{CN}) to which they give rise. As a result, the data serve our purpose more adequately than they otherwise could.

It should be noted that the aim of the method is not greater precision of values. There is none of the emphasis, so often completely unjustified, upon numerical "refinement" of results, such as one finds in much of the current use of the so-called "corrections." The aim of the method is rather to answer questions which without its aid would not be answered at all. Moreover, the mathematical method does not "manipulate" the data in the same sense that many of the current transformations do, and this is true in spite of the fact that it involves an unusual number of arithmetical operations upon the data. To transform a given series into reciprocals or logarithms for the sole reason that such a transformation gives one somewhat higher correlation coefficients is a questionable procedure. But to go through a much more elaborate process of transformation, when this process has a specific meaning in terms of the actual problem being studied, is quite a different matter. The proper criterion for choosing methods of analysis would seem to be not that the methods be as simple as possible, but that, simple or complex, they should at all points be significant in terms of the problem under investigation.[1]

It is perhaps unfair to the mathematical method that it proceeds so obviously by means of the accumulation of assumptions. This apparent weakness, however, constitutes from one point of view a considerable strength. Any line of reasoning proceeds in somewhat the same fashion, i.e. by the addition of premises either explicitly stated or tacitly assumed. It is the peculiar virtue of the mathematical method that it brings to light a greater proportion of the foundations underlying an argument than the "literary" method. Furthermore, the precise statement of assumptions not only calls attention to them, but also facilitates a discussion of the important question as to how closely they fit the actual facts. Finally, while the mathematical method proceeds by the accumulation of rigidly formulated assumptions, and yields its results in precise numerical form, these results are themselves subject to broad interpretation. It is the "general magnitude" of the measures in Table II rather than their precise values which should interest us.

The methodological difficulties which characterize the present problem, namely, the impossibility of measuring the two underlying factors, are often found in other problems which we should like to attack. The mathematical method furnishes a means of indirect approach by which both general non-statistical information and related statistical series can be made to yield results which would have been yielded by quantitative data directly concerning the elements of the problem. This type of analysis offers the possibility of a much more complete exploitation of the statistical information now available than that yielded by the "empirical" methods of ordinary statistical procedure.

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[1] Cf. M. C. Rorty, "Statistics and the Scientific Method," this JOURNAL, March, 1931, p. 8.

GRAPHIC COMPARISONS BY BARS, SQUARES, CIRCLES, AND CUBES

By Frederick E. Croxton, *Columbia University*, and Harold Stein, *Brooklyn College*[1]

In an earlier issue of this Journal an attempt was made to evaluate bar charts and pie diagrams as graphic devices for showing component parts.[2] The present article deals with the relative merits of bars, squares, circles, and cubes for showing simple comparisons. Most users of statistical charts have been accustomed to believe that linear comparisons, represented by bar charts, can be judged with much more accuracy than can area comparisons, such as squares and circles, and that either is superior to volume comparisons, such as cubes. It is the purpose of this investigation to test these types of diagrams to ascertain which, if any, may be preferable from the point of view of the accuracy of the estimates made from them.

The relationships shown by the squares and circles used in this study were represented by the respective areas of the diagrams, while the relationships shown by the cubes were represented by their volumes. The fact that the actual volume of a solid can be only suggested by a two-dimension drawing may be one of the reasons why the accuracy of judgments based upon the drawings of cubes proved to be relatively low. In popular publications comparisons by circles, squares, cubes, and various pictorial means are frequently drawn on a linear basis rather than upon the proper area or volume basis. Furthermore, the reader is frequently at a loss to know upon what basis they are drawn. Careful computations have revealed that some diagrams, whether considered as linear, area, or volume comparisons, give only a very rough approximation of the figures which they undertake to present.

The data which follow are the results of estimates made by 550 observers and the diagrams used were 40 in number. The 40 diagrams, each on a separate card, formed nine sets. Each set consisted of a comparison by means of bars, squares, circles, and cubes showing the same ratio, as shown in Chart I; in addition an alternate arrangement of squares and circles with the diagrams centered as in Chart II, was included in two of the sets. The diagrams were presented one at a

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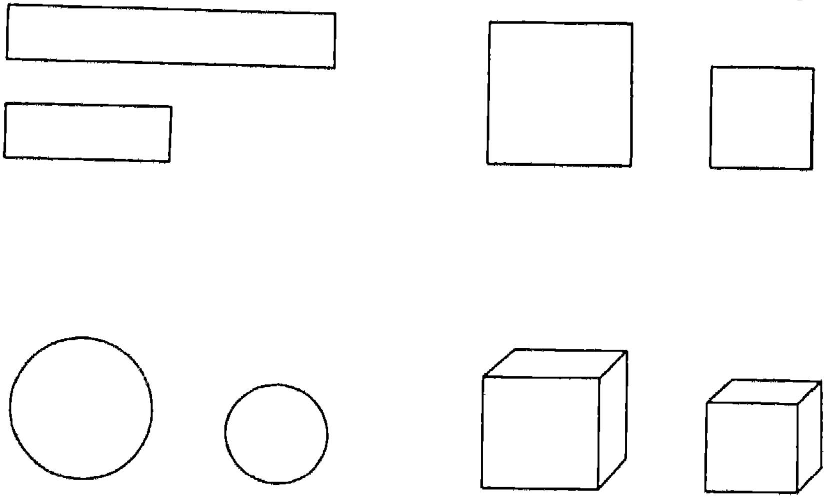
[1] The writers wish to express their gratitude to those instructors and students who made it possible to obtain the data used in this analysis and to Mr. William Madow and Mr. Charles H. Wittmann who assisted in the computations.

[2] "Bar Charts Versus Circle Diagrams," by Frederick E. Croxton and Roy E. Stryker, this Journal, December, 1927.

CHART I

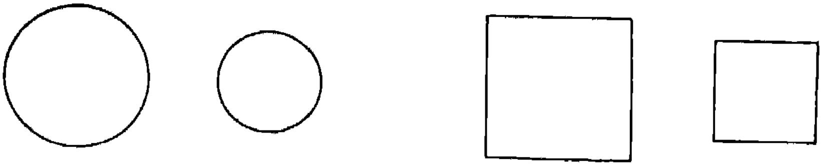
BARS, SQUARES, CIRCLES, AND CUBES SHOWING 50 TO 100 RELATIONSHIP



time to the observers in such an order that it was not obvious that the charts were in sets. For each diagram the observers undertook to estimate the size of the smaller figure in relation to the larger one. As in the earlier study referred to above, all diagrams were drawn without scales, as in Charts I and II, in order that the estimates of the observers might be based upon the diagrams alone and not influenced by the scales.

CHART II

CIRCLES CENTERED AND SQUARES CENTERED SHOWING 50 TO 100 RELATIONSHIP



Bars versus Squares. The first part of Table I presents the results obtained from comparing the estimates made of nine pairs of bars and nine pairs of squares. The mean error resulting from judging the bars was in each instance smaller than that resulting from observing the squares. In eight of the nine instances shown in the table the differences between the mean errors was significant, while in one case it was not.

Bars versus Circles. As shown in the second part of Table I, estimates based upon bars were more accurate than those based upon circles. For each of the nine comparisons of bars and circles the advantage lay with the bars. The differences between the mean errors were significant in eight cases out of the nine.

Bars versus Cubes. Bars showed an even greater superiority over cubes than over either squares or circles. The third part of Table I indicates that in each case the mean error resulting from estimating the proportion shown by bars was smaller than the mean error resulting from estimating the cubes. In each case, also, the difference between the mean errors was significant.

TABLE I

ERRORS RESULTING FROM ESTIMATES OF BARS AND SQUARES, BARS AND CIRCLES, AND BARS AND CUBES

Percentage shown	Mean error for bars	Mean error for other diagram	Advantage in favor of:	Observed difference	Difference ÷ σ difference	Significant?
Bars and Squares						
2.00	2.42	2.50	bars	.08	.4	no
12.50	2.83	5.07	bars	2.24	4.6	yes
16.67	2.98	5.17	bars	2.19	6.1	yes
25.00	3.04	4.36	bars	1.32	3.1	yes
33.33	2.55	8.77	bars	6.22	13.8	yes
50.00	1.54	15.58	bars	14.04	33.4	yes
66.67	3.67	12.49	bars	8.82	26.7	yes
70.00	4.44	11.92	bars	7.48	27.7	yes
90.00	3.00	4.73	bars	1.73	8.2	yes
Bars and Circles						
2.00	2.42	2.78	bars	.36	2.1	?
12.50	2.83	6.21	bars	3.38	6.8	yes
16.67	2.98	6.37	bars	3.39	10.0	yes
25.00	3.04	6.47	bars	3.43	9.5	yes
33.33	2.55	8.72	bars	6.17	15.0	yes
50.00	1.54	9.73	bars	8.19	21.6	yes
66.67	3.67	8.98	bars	5.31	15.2	yes
70.00	4.44	9.37	bars	4.93	16.4	yes
90.00	3.00	6.52	bars	3.52	15.3	yes
Bars and Cubes						
2.00	2.42	7.16	bars	4.74	16.9	yes
12.50	2.83	10.02	bars	7.19	13.8	yes
16.67	2.98	14.41	bars	11.43	21.2	yes
25.00	3.04	19.23	bars	16.19	24.5	yes
33.33	2.55	19.18	bars	16.63	29.7	yes
50.00	1.54	19.83	bars	18.29	42.5	yes
66.67	3.67	14.64	bars	10.97	32.3	yes
70.00	4.44	14.31	bars	9.87	31.8	yes
90.00	3.00	5.96	bars	2.96	12.9	yes

Squares versus Circles. From the data shown in the first part of Table II it would appear that there is little difference in the accuracy of estimates based on squares and circles. In five instances the mean error in estimating the squares was smaller than the mean error in estimating the circles; in two of these the difference between the means was significant and in a third it was probably significant. In four instances the mean error in estimating the circles was smaller than the mean error in estimating the squares; in three of these the difference between the means was significant.

Squares versus Cubes. Estimates based upon squares are clearly more accurate than those based upon cubes. The second part of Table II shows that in each instance the mean error in estimating the squares was smaller than that in estimating the cubes and that in each instance the difference between the mean errors was significant.

TABLE II
ERRORS RESULTING FROM ESTIMATES OF SQUARES AND CIRCLES, AND SQUARES AND CUBES

Percentage shown	Mean error for squares	Mean error for other diagram	Advantage in favor of:	Observed difference	Difference ÷ σdifference	Significant?
			Squares and Circles			
2.00	2.50	2.78	squares	.28	1.3	no
12.50	5.07	6.21	squares	1.14	2.2	?
16.67	5.17	6.37	squares	1.20	2.9	probably
25.00	4.36	6.47	squares	2.11	4.8	yes
33.33	8.77	8.72	circles	.05	.1	no
50.00	15.58	9.73	circles	5.85	10.8	yes
66.67	12.49	8.98	circles	3.51	9.2	yes
70.00	11.92	9.37	circles	2.55	7.3	yes
90.00	4.73	6.52	squares	1.97	7.8	yes
			Squares and Cubes			
2.00	2.50	7.16	squares	4.66	14.6	yes
12.50	5.07	10.02	squares	4.95	9.5	yes
16.67	5.17	14.41	squares	9.24	16.0	yes
25.00	4.36	19.23	squares	14.87	21.2	yes
33.33	8.77	19.18	squares	10.41	15.3	yes
50.00	15.58	19.83	squares	4.25	7.5	yes
66.67	12.49	14.64	squares	2.15	5.8	yes
70.00	11.92	14.31	squares	2.39	6.8	yes
90.00	4.73	5.96	squares	1.23	5.3	yes

Circles versus Cubes. Estimates based upon circles seem to be more accurate than those based upon cubes. In Table III it may be seen

TABLE III
ERRORS RESULTING FROM ESTIMATES OF CIRCLES AND CUBES

Percentage shown	Mean error for circles	Mean error for cubes	Advantage in favor of:	Observed difference	Difference ÷ σdifference	Significant?
2.00	2.78	7.16	circles	4.38	14.6	yes
12.50	6.21	10.02	circles	3.81	7.1	yes
16.67	6.37	14.41	circles	8.04	14.1	yes
25.00	6.47	19.23	circles	12.76	19.3	yes
33.33	8.72	19.18	circles	10.46	16.1	yes
50.00	9.73	19.83	circles	10.10	18.4	yes
66.67	8.98	14.64	circles	5.66	14.5	yes
70.00	9.37	14.31	circles	4.94	13.4	yes
90.00	6.52	5.96	cubes	.56	2.3	?

that in eight instances the mean error in estimating circles was smaller than the mean error in estimating cubes and that in each of these instances the difference between the means was significant.

Squares centered versus other forms. As stated above, two diagrams of squares were included in which the squares were centered as in Chart II. As indicated in Table IV estimates made from bars appear to be more accurate than those made from squares centered, and estimates based upon squares centered are more accurate than those based upon cubes.

One reason for including squares centered was to ascertain if estimates made from them were more or less accurate than estimates made from squares drawn to the same base line. There seems to be no clear evidence in Table IV that either is superior. No conclusive statement can be made as to the relative merits of squares centered on the one hand and of circles, and circles centered on the other.

TABLE IV
ERRORS RESULTING FROM ESTIMATES OF SQUARES CENTERED AND OTHER DIAGRAMS

Percentage shown	Mean error for squares centered	Mean error for other diagram	Advantage in favor of:	Observed difference	Difference ÷ σ difference	Significant?
Squares Centered and Bars						
25.0	3.09	3.04	bars	.95	2.4	?
50.0	12.10	1.54	bars	10.56	27.1	yes
Squares Centered and Squares						
25.0	3.99	4.36	squares centered	.37	.8	no
50.0	12.10	15.58	squares centered	3.48	6.4	yes
Squares Centered and Circles						
25.0	3.99	6.47	squares centered	2.48	6.2	yes
50.0	12.10	9.73	circles	2.37	4.6	yes
Squares Centered and Circles Centered						
25.0	3.99	6.79	squares centered	2.80	6.5	yes
50.0	12.10	10.95	circles centered	1.15	2.2	?
Squares Centered and Cubes						
25.0	3.99	19.23	squares centered	15.24	22.4	yes
50.0	12.10	19.83	squares centered	7.73	14.1	yes

Circles centered versus other forms. Two sets of circles centered (as in Chart II) were also included. Table V indicates that estimates based upon bars were more accurate than those based upon circles centered and that estimates based upon circles centered were more accurate than those based upon cubes. It was thought that estimates based upon circles centered might prove to be more or less accurate than estimates based upon circles drawn to the same base line. The data of Table V show no definite proof that either is superior. No conclusive statement can be made as to the relative merits of circles centered on the one hand and of squares, squares centered, and circles on the other hand.

TABLE V

ERRORS RESULTING FROM ESTIMATES OF CIRCLES CENTERED AND OTHER DIAGRAMS

Percentage shown	Mean error for circles centered	Mean error for other diagram	Advantage in *favor of:*	Observed difference	Difference + σdifference	Significant?
Circles Centered and Bars						
25.0..................	6.79	3.04	bars	3.75	9.4	yes
50.0..................	10.95	1.54	bars	9.41	23.5	yes
Circles Centered and Squares						
25.0..................	6.79	4.36	squares	2.43	5.2	yes
50.0..................	10.95	15.58	circles centered	4.63	8.4	yes
Circles Centered and Squares Centered						
25.0..................	6.79	3.99	squares centered	2.80	6.5	yes
50.0..................	10.95	12.10	circles centered	1.15	2.2	?
Circles Centered and Circles						
25.0..................	6.79	6.47	circles	.32	.8	no
50.0..................	10.95	9.73	circles	1.22	2.3	?
Circles Centered and Cubes						
25.0..................	6.79	19.23	circles centered	12.44	18.3	yes
50.0..................	10.95	19.83	circles centered	8.88	15.0	yes

The results of this quantitative evaluation of the relative merits of bars, squares, circles, and cubes may be summed up as follows:

(1) Estimates based upon bar charts were more accurate than estimates based upon squares, circles, or cubes.

(2) Estimates based upon squares and estimates based upon circles showed no conclusive evidence that one form of presentation is superior to the other.

(3) Estimates based upon squares were more accurate than estimates based upon cubes.

(4) Estimates based upon circles were more accurate than estimates based upon cubes.

(5) Estimates based upon squares centered and upon circles centered were more accurate than estimates based upon cubes, but less accurate than estimates based upon bars.

(6) In making comparisons by means of squares and circles it appears (upon limited evidence) that it makes no difference in the accuracy of estimates whether the figures be centered or drawn upon the same base line.

It will be noted (Chart I) that the bars used in this study were arranged one above the other and that the other figures were arranged side by side. While this is the method of arrangement most frequently encountered, it raises several points which must be left for later determination: Are estimates more accurate when based upon horizontal or vertical bars? If squares, circles, or cubes are to be used, is it preferable to arrange them side by side or one above the other? If vertical bars yield less accurate estimates than horizontal bars are they still clearly preferable to squares, circles, and cubes?

THE USE OF "TRENDS IN RESIDUALS" IN CONSTRUCTING DEMAND CURVES

BY L. H. BEAN AND G. B. THORNE, *Bureau of Agricultural Economics*

The adoption of various devices for eliminating trends in time series has been influential in promoting price analysis, but these devices have not yet removed certain difficulties arising from the trend factor in constructing demand and supply curves or in forecasting. H. L. Moore supplied the initial impetus when he showed how demand curves could be developed by eliminating trend in one of two ways, by expressing data either as percentages of trend or as percentage first differences. Then B. B. Smith showed how the advantages of both of these methods could be combined in multiple correlation to obviate the weakness inherent in the first difference method. Recognizing certain weaknesses in adjusting each series of data for its separate trend, Smith further showed how to avoid this individual adjustment by using time as an independent factor, to obtain a sort of composite net trend derived from residual variations related to time, but unrelated to the other independent factors. Each of these devices tended to widen the possibilities of price analysis. They are all in current use with a tendency in favor of the composite trend in residuals.[1]

One of the attractive features of this latter device is that it enables one to deal specifically with a very few factors, to treat all other factors known or unknown in a sort of catch-all fashion, on the assumption that these "all other factors" have a composite influence which varies systematically or uniformly with time and that they can by this device be "held constant."

In view of the growing use of this latter device for handling the trend element, and the added impetus it is likely to give to price analysis, it is the purpose of this article to point out certain dangers that lurk in this assumption, and certain problems that the analyst should be aware of, particularly as they affect the construction and nature of demand (or other) curves and as they bear on forecasting from the derived curves and trends.

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[1] For examples see, B. B. Smith, *Factors Affecting Price of Cotton;* U. S. Department of Agriculture *Technical Bulletin No. 50;* H. Schultz, *Meaning of Statistical Demand Curves;* L. H. Bean, "Farmers' Response to Price," *Journal of Farm Economics*, July, 1929.

The elimination of trend by the first difference method has the outstanding weakness that the percentage change for any one point in the series is affected by whatever error there may be in the preceding items. While this difficulty can be obviated by expressing the data as ratios to a trend, this latter procedure is often undesirable. In the first place, the kind of trend to eliminate depends on the trends in associated variables. Secondly, adjusting data for trend may eliminate one of the factors under investigation. For example, when H. L. Moore adjusted for trend and then correlated adjusted production and price of pig iron, he missed the negative relation between production and price and obtained instead the so-called positive demand curve. Both relations would have appeared had he made use of the simultaneous method of treating trends. But this method too has its weaknesses as the following examples will illustrate. The examples are taken from studies dealing with supply and demand factors in retail prices of beef and pork for the post-war period.

One of the purposes of this study is to determine the demand curve which according to economic theory would show the quantities which would be purchased at various specified prices at any one instant of time by all consumers in the United States combined; in other words, to show the shifts in the amount which would be purchased if the price were changed and demand conditions remained unchanged. Lacking a satisfactory method for determining what quantities buyers stand ready to buy for various specified prices at a certain instant of time, the usual alternative was first adopted of relating yearly quantities taken and prices paid. A scatter diagram of consumption and price indicated that the relation between these two factors shifted with time, that the shift was practically uniform. Consequently, correlating price with consumption and time, there is revealed a well defined demand curve and a trend in residuals uniformly related to time. The upper part of Chart I shows this relation between consumption of beef and a composite retail price of beef (representing about 65 per cent of the carcass). The lower part of the chart shows the residuals from the consumption-price relationship plotted against time.[1]

These results are typical of many cases where residuals related to time have been used to indicate changes in demand, or shifts in the demand schedule, and where it has been possible by so doing to obtain a close relation between supply and price. By using this device for holding constant all other factors (of the nature of which the analyst is usually ignorant) that vary with time, it is generally concluded that the

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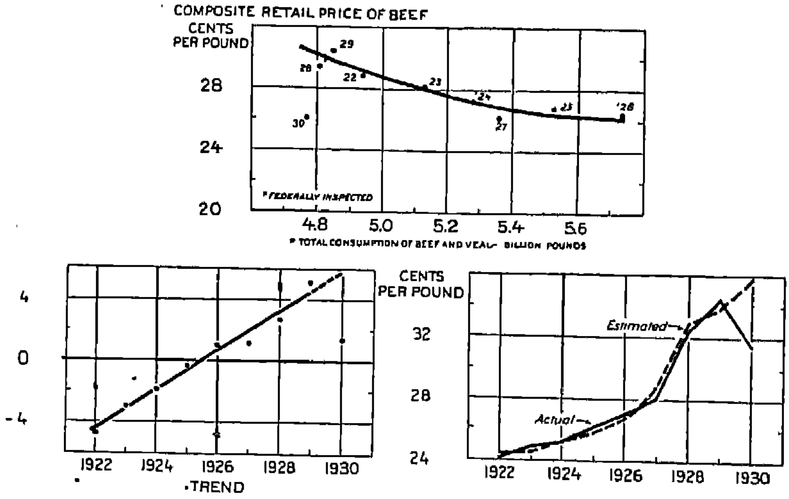
[1] For the graphic method of correlation used in the four analyses contained in this paper, see this JOURNAL, December, 1929, p. 386, and December, 1930, p. 428.

CHART I

RELATION OF BEEF PRICES TO CONSUMPTION AND TREND, 1922-1930



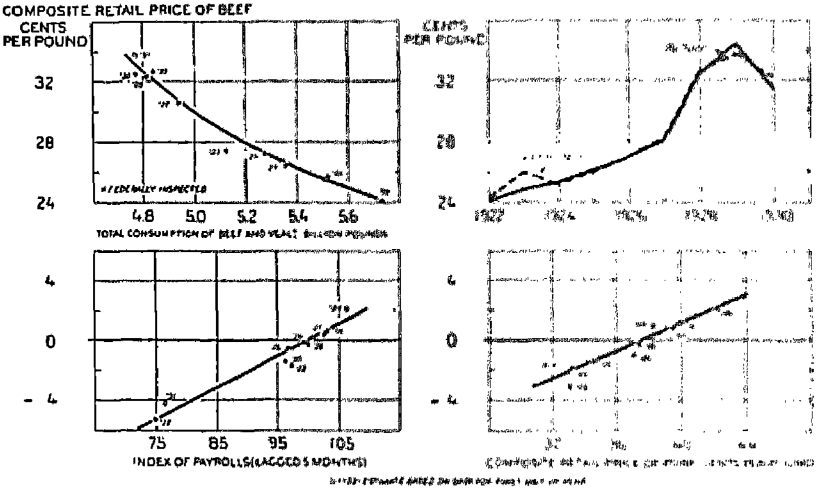
close relation between quantities sold and price received approximates the demand curve of theory and that the trend in residuals represents a vertical shifting of that curve. This method has been applied in constructing "demand curves" or supply and price relations for cotton, wheat, corn, apples, potatoes, sugar and a number of other commodities. No statistical explanation is given for the trend in residuals in these studies. Statements such as that it represents shifts in demand due to "growth in population etc.," or that it is "a catch-all for all the disturbing factors" in a dynamic society, constitute in most cases all the attention which has been given to explaining the trend.

In terms of the example in Chart I it might be assumed that the regular trend represents a growth in demand for beef during the period (1922–1929) and that the relation between consumption and price constitutes a true demand curve. Obviously the only justification for assuming that the trend in residuals represents changes in demand is that it moves along a regular course with time and that by removing it, a smooth logical relation of consumption and price is revealed. Furthermore, for practical purposes, the results imply that the elements which brought the regular increase in demand are sufficiently basic and stable to warrant a projection of the trend in making a price or consumption forecast. But when the data for 1930 are applied to the curves, they reveal the danger of making such an assumption in forecasting, since a forecast for 1930 from this preliminary analysis would have been woefully far from accurate.

This type of analysis thus raises certain questions: (1) Does the uniform trend in residuals actually represent an upward trend or shift in the demand curve? (2) If the residuals were explained by the separate elements which it represents, would it change materially the shape of the demand curve? (3) Would dealing with the separate factors causing shifts in the demand schedule instead of using a composite trend be more reliable in forecasting? The answers to these questions are indicated by a further analysis of retail beef prices. While these answers are of course to be taken only as applying to beef, they are intended also as illustrative of similar difficulties that may be found in other analyses where the method in question is applied.

CHART II

RELATION OF BEEF PRICES TO CONSUMPTION, CONSUMER INCOMES, AND PORK PRICES, [illegible]

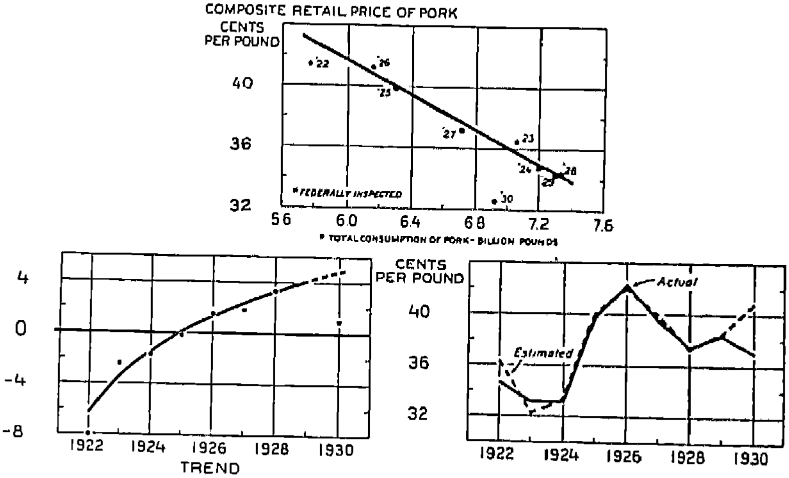


The reasons why a projection of the upward trend would have given an erroneous forecast for 1930 are revealed in Chart II. This analysis differs from the preceding one in the important respect that instead of using the time factor as a catch-all for forces which cause shifts in the demand curve for beef, there are included two of those forces or factors and they are treated separately in their influence on beef prices. These two factors are the retail price of pork, and the buying power of consumers as measured by an index of factory payrolls. In this example the three factors, consumption, retail pork prices and money incomes of consumers explain or account for most of the annual variations in beef prices. The changes in demand which in the first analysis appeared to be uniform are here revealed to have been the result of changes in pork prices and in consumers' incomes. By comparing Charts I and II it becomes evident (1) that the changes in demand for beef between 1922 and 1929 did not conform to a regular upward trend, (2) that the relation between consumption and price as shown in Chart II differs from that in Chart I, the latter showing nearly a 4 cent decline in price from 30.2 cents to 26.4 cents for the given range of consumption, while the other a 9 cent decline from 33.2 to 24.1 cents.

Results obtained from a similar treatment of the supply and demand factors in retail pork prices are shown in Charts III and IV. Again it was found that by assuming a relation between consumption and price such as shown in the upper part of Chart III a well defined demand curve and regular upward trend in residuals related to time could be established from 1922 to 1929. This trend in residuals, although curvilinear rather than linear, is equally as regular in its year-to-year changes as the trend revealed in the study of beef prices. Furthermore, just as in the latter, a projection of the trend for the purpose of making a forecast for 1930 would have resulted in serious error.

CHART III

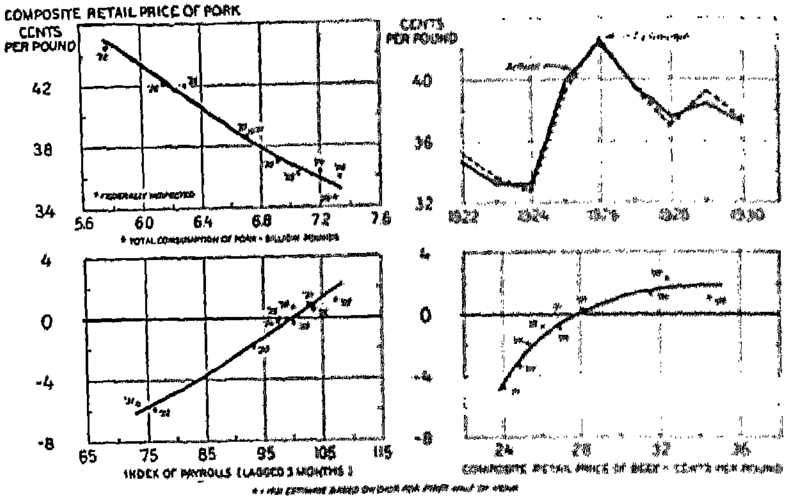
RELATION OF PORK PRICES TO CONSUMPTION AND TREND, 1922-1930



By substituting for the "time" element two important factors affecting the demand for pork, namely the money incomes of consumers as measured by an index of factory payrolls and retail beef prices, most of the annual variations in pork prices are explained for the entire period 1922–1930. Results of this analysis are shown in Chart IV. The

CHART IV

RELATION OF PORK PRICES TO CONSUMPTION, CONSUMER INCOMES, AND BEEF PRICES, 1922-1930



same general conclusions then, are to be drawn from a comparison of Charts III and IV as are indicated by a comparison of Charts I and II, for it is again evident (1) that the changes in demand between 1922 and 1929 did not conform to a regular upward trend, (2) that the relation between consumption and price when the actual demand factors are used differs from that revealed when an unexplained trend related to time is used to represent the changes in demand, a linear relation being indicated in one case and a slightly curvilinear one in the other, and (3) that the decrease in demand in 1930 was associated with a decrease in consumer incomes and a decline in retail prices of the most important competing meat. It may be observed, however, that there is only a slight difference in the two consumption-price relations shown in Charts III and IV, in contrast to the marked difference in these relations in Charts I and II.

These two examples illustrate the dangers involved in using "time" as an independent factor in correlation analysis, regardless of whether the objective is to construct a forecasting formula or to derive a demand curve, or both. The element of judgment is vitally important in making forecasts. The time has not come, and probably never will, when reliable forecasts can be made simply through the application of empirical formulae without regard to the reasonableness of the forecasts in view of other indications. It becomes additionally difficult to appraise the reliability of a forecast based on statistical analysis when it involves the use of an unexplained trend related to time and when the analyst is uninformed as to the nature of the factor or factors represented in the trend. This holds true even though the trend is an accurate reflection of the composite influence of factors other than those included in the study, and if the time factor reveals a spurious relationship such as in the two studies described above, the analysis is of dubious value. The fact that in one of the above illustrations there was only a small difference in the consumption-price relations suggests that the time factor may sometimes be employed to obtain a satisfactory net relation for a given period, but unless the result is also tested by a more comprehensive analysis the validity of that net relation must remain in doubt. Even a larger number of observations than that used in these illustrations would not remove the unreliability of results based on a "time" factor. It is true that the larger the number of observations, the greater the probability that the trend in residuals is not a spurious relation. Even though it be a true relation, however, it may break down after the end of, say, 20 or 25 years just as it may after a shorter period. Practically all long-time price analyses employing "trend in residuals" have demonstrated this weakness.

NOTES

SOME CHARACTERISTICS OF THE GRAPHIC METHOD OF CORRELATION

By Warren C. Waite

Methods of graphic correlation have been presented recently, and have been widely employed, particularly in the study of agricultural prices. The procedures are of two principal types. The first is the curvilinear correlation method in which a regular multiple correlation is first computed and the net regression lines later modified by graphic methods in view of the position of the residuals about the partial regression lines. The second, more commonly called the "graphic method," starts with a gross regression between two variables and successively compares the relation of residuals with the values of new variables. The comments of this note apply only to the latter method. The cases treated are for simplicity of only three variables and the relationships considered linear. Moreover the regression lines are all those of least square fit, since these permit a somewhat more rigorous demonstration of the point. The conclusions are applicable by analogy to the cases where the lines are not those of least square fit and where they are curvilinear.

The regression equation for the classical procedure in correlation is of the form $x_{1e}=b_{12.3}x_2+b_{13.2}x_3$, where x_{1e} is the estimated value of x_1 and $b_{12.3}$ and $b_{13.2}$ are the net regressions. The estimating equation for the graphic procedure is of the form $x_{1e}=b_{12}x_2+b_{(1.2)3}x_3$, where b_{12} is the gross regression between x_1 and x_2, and $b_{(1.2)3}$ is the regression between the residuals of x_1 after its estimation from x_2 (i.e. $x_1-b_{12}x_2$) and x_3. In case we begin our graphic procedure with x_3 our equation is of the form $x_{1e}=b_{13}x_3+b_{(1.3)2}x_2$. We need to examine, in consequence, the x_{1e} arrived at by the various methods, and how b_{12} may differ from $b_{12.3}$ and $b_{(1.2)3}$ from $b_{13.2}$.

Consider first, the case where there is no correlation between the independent variables, i.e. $r_{23}=0$. We know (Yule, p. 237) that

$$b_{12.3}=\frac{b_{12}-b_{13}b_{32}}{1-r^2_{23}}. \tag{1}$$

Similarly it can be shown that [1]

$$b_{(1.2)3} = b_{13} - b_{12}b_{23}. \tag{2}$$

When $r_{23}=0$, it is apparent from (1) that $b_{12}=b_{12.3}$ and $b_{13}=b_{13.2}$, and from (2) that $b_{(1.2)3}=b_{13}$ and $b_{(1.3)2}=b_{12}$. In these circumstances the two methods give identical results, and it makes no difference which independent variable is used first in the graphic approach.

In the cases where there is correlation between the independent variables, and this is the situation in the majority of our problems, the result is not so fortunate. We see from (1) that b_{12} is not equal to $b_{12.3}$ and will differ markedly if r_{23} is large. Writing $b_{13.2}$ in the form of (1) we have:

$$b_{13.2} = \frac{b_{13} - b_{12}b_{23}}{1 - r^2_{23}}. \tag{3}$$

Examining (2) and (3) we see the difference lies in the inclusion of the $1-r^2_{23}$ in the denominator of (3). This means that when r_{23} is large the two regressions will differ materially. Moreover, it will be possible for $b_{(1.2)3}$ to be of opposite sign from b_{13} whenever the product of b_{12} and b_{23} is of the same sign and greater than b_{13}. In such cases we will attribute a positive or negative influence to x_3 depending upon whether we begin our analysis with x_3 or include it later.

The estimating equation using (2) above, becomes

$$x_{1c} = b_{12}x_2 + (b_{13} - b_{12}b_{23})x_3, \text{ or} \tag{4}$$

$$x_{1c} = b_{13}x_3 + (b_{12} - b_{13}b_{32})x_2 \tag{5}$$

depending upon the variable with which we begin our analysis. In these equations $b_{12}x_2$ and $b_{13}x_3$ are common to both. It is thus evident that the x_{1c} will be the same in the two cases only if $b_{12}b_{23}x_3$ is equal to $b_{13}b_{32}x_2$, and that this will seldom be true. Thus we will generally secure different estimates of our dependent variable depending upon the order in which we consider our independent variables, and our index of correlation will differ somewhat.

From the above we may conclude, even though straight lines of least square fit are used for the regressions:

(1) That the graphic method of correlation will generally yield

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[1] This may be shown as follows:

$$r_{x_{1.2}x_3} = \frac{\dfrac{\Sigma x_{1.2}x_3}{N}}{\sigma_{x_{1.2}}\sigma_3} = \frac{\dfrac{\Sigma(x_1 - b_{12}x_2)x_3}{N}}{\sigma_1(1-r^2_{12})^{1/2}\sigma_3} = \frac{\dfrac{\Sigma x_1x_3}{N} - b_{12}\dfrac{\Sigma x_2x_3}{N}}{\sigma_1(1-r^2_{12})^{1/2}\sigma_3} = \frac{r_{13}\sigma_1\sigma_3 - r_{12}\dfrac{\sigma_1}{\sigma_2}r_{23}\sigma_2\sigma_3}{\sigma_1\sigma_3(1-r^2_{12})^{1/2}} = \frac{r_{13} - r_{12}r_{23}}{(1-r^2_{12})^{1/2}}$$

$$b_{(1.2)_3} = r_{x_{1.2}x_3}\frac{\sigma_{x_{1.2}}}{\sigma_3} = \frac{r_{13} - r_{12}r_{23}}{(1-r^2_{12})^{1/2}} \cdot \frac{\sigma_1(1-r^2_{12})^{1/2}}{\sigma_3} = b_{13} - \frac{\Sigma x_1x_2}{N\sigma_1\sigma_2} \cdot \frac{\Sigma x_2x_3}{N\sigma_2\sigma_3} \cdot \frac{\sigma_1}{\sigma_3} = b_{13} - b_{12}b_{23}$$

different results from the classical procedure in the estimated values of x_1, the multiple correlation coefficient, and the slopes of the various regression lines, except for the case where the independent variables are uncorrelated.

(2) That the results of the graphic method are not in themselves consistent, but yield different estimated values of x_{1e}, indexes of multiple correlation and slopes of regression lines, if the order in which the independent variables are considered is changed.

A MODEL TO AID IN TEACHING PARTIAL CORRELATION

BY HELEN M. WALKER AND WALTER N. DUROST, *Teachers College, Columbia University*

One of the more difficult tasks in the teaching of elementary statistics is to build concepts, to imbue statistical formulas with concrete meaning for the beginner. Many persons not trained in mathematics and not able to think easily in abstract symbolism are now finding it necessary to have some acquaintance with the general method of statistics. Consequently any model which helps the beginner to comprehend the meaning of an important formula is worthy of attention.

The Data. The height, weight and age data for Glasgow school boys, gathered by Miss Ethel Elderton and published in Vol. X of *Biometrika,* were used in making the correlation model. The original form of these data proved less convenient than the redistribution made by Isserlis and reported in Vol. XI of *Biometrika,* so the latter was employed. Age levels 7 to 13 only were used.

The Construction. Seven plates of demi-plate glass approximately 8 by 20 inches, were built up in skyscraper fashion, each being separated from the other by four small rubber feet. Upon each plate the frequency distribution for the correlation between height and weight for a given age was plotted, using for the purpose Denison gummed numbers. The distribution was first plotted on a chart the size of the plate, then the glass plate was superimposed upon this chart, and the numbers placed over the proper cells as indicated through the glass. The regression lines, first drawn on the charts, were represented on the glass by narrow strips of passepartout tape, one color being used for the regression of height on weight and a different color for the regression of weight on height. The regression relative to age could not be shown on this model.

The distribution for the zero order r between height and weight was drawn on tracing cloth and this is used as the base on which the model rests. The intersection of the mean height and mean weight for the total group is represented on each plate by a cross in red, and the intersections of the means for each year group by a small star on the plate for that year.

The completed model is housed in a cabinet which has a false bottom of glass beneath which electric light bulbs have been placed, thus permitting the model to be seen under optimum conditions.

Partial and Zero Order Correlations. First of all, this model helps the beginner to visualize a three-way distribution of frequency, to see the two-way distribution with which he has been working open out into a third dimension when measurement is made on a new variable. Thus it prepares him for the analytical consideration of problems dealing with many variables, bridging the gap between the two-dimensional scatter diagram of which he has complete graphical comprehension and the multi-variate regression problems which the student not trained in mathematics sometimes finds very puzzling.

The zero order correlation between height and weight is represented by a scatter diagram plotted on a sheet beneath the model, this scatter diagram showing the vertical projection of all the seven separate diagrams on one single plane. The zero order correlation between height and age could be represented by a horizontal projection of all the scores upon the narrow end of the cabinet and the zero order correlation between weight and age by a horizontal projection upon the longer side of the cabinet.

Upon each of the seven sheets of plate glass is the correlation distribution of height and weight for a single age group, and thus each one *approximates* the partial correlation between height and weight with age held constant. These correlations are of course not strictly uniform for the different ages, and therefore no one of them could be taken as identical with the partial correlation. Furthermore, in each section age varies slightly, within the narrow limits of one year, so for this reason also we cannot say that the correlations represented on the various sheets *are* the partial correlation, but only that they suggest and approximate it.

If vertical sections are taken through the mass at right angles to the weight axis, each being one weight-interval in width, each such section is seen to contain a distribution of the height and age for children of approximately uniform weight. Thus we get a picture suggesting the partial correlation between height and age when weight is constant. The partial correlation between weight and age with height held constant is suggested by taking vertical sections through the mass at right angles to the axis of height.

Standard Error of Estimate. The total mass may be thought of as cut into narrow slices first in one direction, then in another. Out of this we may select that portion of the mass common to a given height and a given weight. This will be a vertical column within which age varies freely, but within which the variation of height and weight is narrowly restricted to the width of their respective class intervals. Centering attention on the frequency in this column we get a suggestion of a frequency distribution in age with height and weight held constant. From this we pass readily to the concept of $\sigma_{a.hw}$. Of course the student must be warned that the standard deviation of any single column is not identical with $\sigma_{a.hw}$ because (1) the distribution is not strictly homoscedastic and (2) variation in height and weight is not entirely eliminated within the column but only restricted. In the same way, $\sigma_{h.aw}$ may be given tangible meaning by centering attention on the distribution of frequency within a horizontal bar which is the intersection of one of the horizontal planes and a vertical slice perpendicular to the weight axis. This bar will extend in a direction parallel to the axis of height. In similar fashion $\sigma_{w.ah}$ can be suggested by the frequency distributions in horizontal bars parallel to the weight axis.

Regression Lines and Planes. For each age level, lines have been drawn to show the regression of height on weight and of weight on height. When the observer is in a favorable position, the seven lines for the regression of weight on height indicate a surface, the regression surface for predicting weight from height and age. This surface is not a plane, but is warped. If curved regression lines had been fitted on each plane, instead of lines drawn according to the usual straight line equation, there would have been a double warping. This would have given a more accurate picture of the real relationship, but not necessarily a better instrument for teaching. The regression surface for predicting height on the basis of weight and age is suggested by the seven separate regressions of height on weight. No way has been found to suggest either the third plane or any of the regression lines which involve age. The small stars which are placed at the intersection of the mean height and mean weight for each age fall very nearly on a straight line, which is the intersection of the two regression surfaces portrayed. The mean height and mean weight for the entire table is indicated by a small cross on each plate, the crosses lying in a vertical line. These two lines, the one vertical and the other oblique, intersect at a point where the third regression surface—if it could be shown—would cut the other two.

After these surfaces have been visualized, a truer concept of the standard error of estimate can be obtained in terms of the scattering of all the scores around the regression plane.

A CONSTRUCTIVE PROGRAM FOR PRICE STATISTICS

A technical conference on price statistics was held on September 25 and 26 at the Brookings Institution in Washington, arranged under the joint auspices of the section on Industry and Trade of the Social Science Research Council and of the Committee on Price Statistics of the American Statistical Association. The sponsoring bodies plan to use the recommendations of the conference as the basis for further development in this and in related fields. Criticism of the program outlined by the conference is urgently solicited.[1] The conference recommendations follow in full text.

THE RECOMMENDATIONS

The events of the last two years have brought home to economists and to the business men, to consumers and to the general public, the inadequacy of our existing knowledge of price movements in the United States. No comprehensive general index numbers of retail prices exist. No nation-wide study of budgets has been made since 1919, and as a result the utility of our cost of living index numbers is seriously impaired. Valuable work is being done in the field of wholesale prices, but inadequate funds, the dearth of representative price quotations for certain types of goods and other deficiencies have combined to prevent the development of index numbers yielding all the information currently required. As a consequence it has been impossible to trace accurately the price changes of recent years. This predicament is especially critical in view of the key function of prices in determining the direction and intensity of economic activity and in view of the increasing reliance upon statistical indicators in the development of commercial and public policy.

To the end that this condition may be corrected and that more adequate, more timely, more frequent and comprehensive information concerning price changes may be secured the following recommendations are submitted:

A. *Recommendations Concerning the Preparation of Index Numbers*

1. It is a function of the federal government to construct and with all possible promptness to publish comprehensive and scientifically constructed basic index numbers of wholesale and retail prices, and of living costs. However valuable the contributions of private agencies may be in these fields, it is a proper task of the central government to provide the basic index numbers required for economic and business purposes. Ample funds should be made available for the support of a permanent trained staff to carry on this work and to pursue the continuing research indispensable to its effective performance.
2. The official composite index numbers of wholesale prices and of retail prices should be constructed by a single governmental agency. The basic wholesale price indexes should be published or released as promptly as possible each month and, if possible, each week. If the basic index should prove impracticable on a weekly basis a supplementary index of wholesale [illegible] should be prepared and released each week. The basic index [illegible] should be constructed on a monthly basis.
3. Index numbers of living costs should be constructed to represent the major economic groups in the community and to measure broad changes in national consumption. Such indexes should be published monthly, or at least quarterly. As a basis for accurate index numbers of living costs it is recom-

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[1] Communications regarding the recommendations should be addressed to Meredith B. Givens, Secretary for Industry and Trade, Social Science Research Council, 230 Park Avenue, New York City.

mended that plans be made for a comprehensive study of family budgets to be conducted when normal consuming conditions have been restored. General surveys of family budgets among different classes of consumers must be conducted periodically if accurate index numbers of living costs are to be maintained.[1] Aside from their utility as measures of the position of the consumer in economic society, such indexes meet a variety of special needs in market analysis, in the adjustment of wages and prices, and in the interpretation of economic trends.

4. It is recommended that the official compiling agency should make full use of the technical knowledge and economic contacts of all branches of the government and of the services of various private price-compiling agencies in the development of the materials required for the construction of the basic index numbers. Accordingly, it is suggested that responsibility for the compilation and verification of individual price series should be placed upon the several governmental bodies most closely in contact with various fields of economic activity. In the construction of the official indexes it is urged that full use be made of adequately authenticated series compiled by private agencies.
5. The official index number of wholesale prices should be designed to serve as a general purpose index. To serve specific purposes it is desirable that group index numbers based upon various distinct principles of classification should also be constructed by the governmental agency engaged in this work. More numerous breakdowns are needed than are presented by the wholesale price indexes now available. No one principle of classification is adequate. The compiling and publishing agency should reconsider the breakdowns of the index numbers and as many of the important classifications or groups should be published as may prove practicable. Each of several bases of grouping the items should be employed to make separate breakdowns or separate sets of commodity groupings. This procedure will facilitate regrouping in a number of ways by the compiling agencies or by others. Further research is needed to determine what classifications are most practicable and useful. Among many possible principles in classification the following are suggested:

   a. A classification according to *source*.
      (For example, for farm products, animal products, mineral products and forest products.)

   b. A classification according to *use*.
      (For example, for producers' goods intended for use in capital equipment as distinct from consumers' goods intended for ultimate human consumption.)

   c. A classification according to stages of *manufacture* and *distribution*.
      (For example, for raw, semi-processed and finished goods.)

   d. A classification according to *industry*.

   e. A *geographical* classification.

   It is to be noted that some progress along the lines suggested above has been made.
6. In classifying commodities for the purpose of securing significant group index numbers every effort should be made to develop groups for which comparable data are available relating to volume of production, payrolls, number of employees and other important aspects of economic life. The comparability of price index number groupings and groupings of other statistical data for significant commodity groups and for important industries should add materially to the usefulness of all such measurements. Choice of base periods should be made in part with reference to the need for comparability between various series.

B. *Recommendations Concerning the Collection and Publication of Original Price Series*

1. In the compilation of individual price series certain standard modes of description should be employed and certain standard types of information should be

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[1] The specific problems having to do with indexes of retail prices and of living costs are not fully dealt with here. Some of the general recommendations relate to such indexes, but a more complete program remains to be developed at another time. Detailed suggestions regarding the method and scope of a possible national survey of the cost of living are embodied in a special memorandum developed by the Social Science Research Council in 1929.

gathered. The requirements of exact description will vary from industry to industry and from commodity to commodity, but it is essential that certain minimum standards should be consistently maintained. The basic statistics should be made available in full and should be published by the compiling agency in as much detail as possible together with the weights used in the construction of the composites. Research and investigation should be undertaken to develop standard descriptions covering such points as the following:

a. Concerning the commodity:
  Exact definition of unit employed in price quotations.
  Chemical and physical description of standard graded commodities in as precise terms as possible.

b. Concerning the market:
  Geographical location.
  Economic character.
    (For example, producers', jobbers', wholesalers', or retailers' prices.)
  Exact stage in distribution represented by the quotations.
    (The economic character of the market will be defined in general if the economic functions of buyer and seller are accurately stated. If the market is an organized exchange that fact should be stated.)

c. Concerning the terms of sale:
  Such points as the following should be specifically covered in each case:
  (1) The price in units of value in which the transactions were made.
    (e.g., in cents, dollars, pounds sterling, gold dollars, greenbacks, etc.)
  (2) The statistical nature of the price.
    (e.g., a first of the month quotation, an average of daily quotations, etc.)
  (3) The economic character of the price.
    (e.g., contract or spot price, futures or "bought to arrive.")
  (4) Credit terms.
  (5) Delivery terms.
  (6) Inclusion or exclusion of duty.
    (Applicable to foreign items only.)

d. Concerning the volume of transactions represented by the quotations:
  (This information may not be available in all cases, but for certain classes of commodities it is essential.)

Continuing research is needed to develop uniform standards for adoption by all governmental price-compiling agencies. The above suggestions, which are by no means definitive, are put forward to indicate the type of information which should be available to facilitate the intelligent utilization of price data. Private organizations should be urged to follow the official practice in this field. Governmental bodies should endeavor to secure the adoption of uniform practices on the part of all agencies.

2. In the construction of price indexes a series of average sales realizations should not be used as a substitute for a series of quotations of actual prices except in cases where such realizations have reference to a simple uniform grade of a single commodity. The original price series used in the computation of index numbers should be made available in all cases, preferably in published form. When a number of price series relating to the same commodity are employed in an index all series relating to that commodity should also be combined as a special commodity price composite, constructed by using the same method of weighting employed in the general index provided the prices quoted represent similar conditions of sale, credit and delivery. (Dissimilar types of data, such as spot and future prices for wheat, should not be combined.) These individual composites should be published.
3. Price series for any commodity should be developed to represent the various geographical regions and types of markets. Commodities for which price series are compiled should represent each principal stage of fabrication and distribution. In the case of highly fabricated articles an attempt should be made to eliminate that part of each price change which is due to changes of design.

C. *Recommendations Concerning Needed Organization for Intensive Research*

In order to improve our knowledge of price movements and of price relations the above proposals should be put into practice, in so far as possible. This will require the prosecution of intensive, continuing and comprehensive research as an essential step toward the planning of necessary improvements. Information for all existing price series should be reviewed by a central agency with a view to discovering the gaps in existing price information and to stimulating the compilation of new series to round out the picture of the general price structure.

To this end it is recommended that the American Statistical Association and the Social Science Research Council should take steps toward the establishment of a permanent body for the planning and development of more adequate price statistics. To be effective such a body must be provided with funds. It should actively seek the coöperation of other interested organizations.

Among the possible functions of a continuing organization or permanent agency the following are suggested:

1. The sponsorship of certain types of research.
   a. A historical study of prices and the construction of more accurate long-time comparisons of the general price level.
   b. Special inquiries into such subjects as
      (1) The relations between prices of finished commodities and the prices of raw materials and fuels used in producing them.
      (2) The effect of tariff on prices.
      (3) The factors affecting the prices of by-products.
2. The listing and evaluation of existing original price series, commodity price composites, general and group price indexes and special purpose series such as those presented in public utility rate cases.
3. The experimental development of new index groupings and new weightings in such form that they could subsequently be taken over and kept up currently by other agencies.
4. The experimental collection of data in new fields.
5. The development and current revision of standard specifications in the field of price statistics.

It is understood that this document presents the point of view of the conferees as individuals and in no way involves the opinion of any organization aside from the conference itself.

(Signed) Robert W. Burgess, *Western Electric Company*
Morris A. Copeland, *University of Michigan*
J. Frederic Dewhurst, *Department of Commerce*
E. Dana Durand, *United States Tariff Commission*
Edward T. Frankel, *National Industrial Conference Board*
Meredith B. Givens, *Social Science Research Council*
Royal Meeker, *Index Number Institute, New Haven*
Frederick C. Mills, *National Bureau of Economic Research*
Paul H. Nystrom, *Columbia University*
Carl E. Parry, *Division of Research and Statistics, Federal Reserve Board.*
Malcolm C. Rorty, *American Founders Corporation, New York City*
W. Arthur Shelton, *United States Department of Agriculture*
O. C. Stine, *Bureau of Agricultural Economics*
A. W. Zelomek, *Fairchild Publications*

NOTATION OF COMMENTS AND EXCEPTIONS

The basic wholesale price index should be published or released as promptly as possible each month and, if possible, each week. (See recommendations, item A. 2.)

It is possible to construct a weekly basic index number of wholesale commodity prices. A good weekly index number of wholesale prices is not only useful but essential to current price analysis; therefore this point should be given more emphasis. The weekly index number series should indicate currently and ac-

> curately the course of prices. It will be the more useful of the two in analyzing current situations, and will be useful in measuring variability and marking turning points in long-time price analysis.—O. C. Stine, *Bureau of Agricultural Economics.*
>
> The Conference agreed that both weekly and monthly indexes of wholesale prices should be computed. Naturally this will lead to the *weekly* index becoming the *basic* index because it will be constructed first and the monthly index will be a combination of weekly indexes.—Royal Meeker, *Index Number Institute.*

The official composite index numbers of wholesale prices and of retail prices should be constructed by a single governmental agency. (See recommendations, item A. 2.)

> I do not believe that the committee gave adequate consideration to questions involved in recommending that these two composite index numbers be constructed by a single agency. Obviously there might be some gain in comparability from having these two official index numbers constructed by a single agency, but why not also include the official composite index number of cost of living? The primary concern of the committee is to secure good composite index numbers rather than to indicate assignment or organization of activities in compiling data and constructing these index numbers.—O. C. Stine, *Bureau of Agricultural Economics.*
>
> While I agree with many of the proposals contained in these recommendations, the document as a whole contains recommendations which owing to the time and expense required to accumulate the data would defeat the purposes of an index.—Ethelbert Stewart, *Commissioner of Labor Statistics, U. S. Department of Labor.*

THE PRICE LEVEL SLUMPS OF 1920 AND 1931—WHAT CAUSED THEM?

A dinner meeting of the American Statistical Association was held on Tuesday evening, October 27, 1931, at the Aldine Club, 200 Fifth Avenue, New York City. Four hundred and eighty-three persons were present.

The presiding officer was Dr. Roland P. Falkner, Chief Statistician of the National Industrial Conference Board. In introducing the presiding officer, the Secretary called attention to the remarkable advance which had taken place in statistical technique and economic problems since the time when Dr. Falkner prepared his well-known index numbers of prices. Attention was also called to the fact that these index numbers might well be thought of as initiating a new era in American statistics.

On account of illness, Carl Snyder, Statistician of the Federal Reserve Bank of New York, was unable to be present, hence the gist of the paper which he had prepared was presented by Dr. Warren M. Persons.

It was pointed out in Mr. Snyder's paper that, though we have had four business depressions of major severity since the Civil War, only two, namely those of 1921 and 1931, have been characterized by unusual declines in commodity price levels. During the present depression, indexes of commodity prices at wholesale have fallen between 30 and 40 per cent and the general price level of the Federal Reserve Bank of New York has declined by the unusual amount of 20 per cent.

It is a striking fact that neither the decline in 1920–1921 nor that in 1930–1931 shows any discoverable relationship to changes in the world's total stock of gold, to changes in its stock of monetary gold, or to changes in its rate of gold production. Neither have these price declines shown any close approximation to the gold movement in or out of the United States.

Since the two crises have been so similar in character and apparent causation, the present depression cannot logically be ascribed to the general return of the nations to the gold standard, for, in 1920–1921, the United States was the only one of the larger nations truly on a gold standard. Although gold production was sharply curtailed during the World War, it has, since 1921, been nearly at pre-war volume. This has meant a steady increase in the total stock of gold which was obviously so super-abundant in the years preceding 1915 as to cause a steady rise in the general level of prices in gold-standard countries during the fifteen or twenty years preceding that date. Since 1921, the world's stock of monetary gold has increased at an average rate of about 4 per cent per annum, while basic production, and, therefore, presumably the manufactures and trade of the principal nations of the world, have been rising at an average rate of nearly 3 per cent, practically the same rate prevailing during the sixty or eighty years preceding the World War. There is, then, no apparent evidence of any "gold shortage."

In neither of these last two major crises has there been any apparent relationship between price declines in the United States and the gold movements in or out of this country. In 1918, after the lifting of the embargo, there was a heavy outflow of gold, but this was followed not by a fall in prices but by a violent rise in prices continuing for nearly a year thereafter. During the drastic price decline of 1920–1921, there was, on the other hand, a steady inflow of gold which replaced all the gold lost in 1918–1919 and much more in addition. Yet the fall in prices was the most violent that this country had known since the close of the Civil War.

In the same way, this country had, in 1927–1928, the heaviest loss of gold ever known to this or any other nation up to that time, and the discoverable effect upon prices in 1928 and the early part of 1929 was nearly nil. If we are to assume any direct relationship we must also assume that the effect of these gold movements is not felt for something like a year thereafter. This hypothesis seems improbable.

Furthermore, since the great fall in prices which began in the autumn of 1929, we have had, up to September, a well-nigh continuous inflow of gold but, thus far, it has had no discoverable tendency to check the price decline.

It is widely believed that the present world-wide depression and tremendous fall in prices has been closely related to the so-called maldistribution of gold, that is to the absorption by France and the United States of such a large fraction of the entire available supply. Here we meet with the remarkable paradox that while, in the United States, we have had the most violent fall in prices which we have known in peace times, and a depression that has perhaps exceeded all others in extent of duration, France has, until very recently, had no depression of any consequence and merely a moderate decline in prices—a decline which has affected the prices of their domestic products scarcely at all. This striking contrast is, indeed, one of the outstanding anomalies of the present depression and perhaps affords some clue as to its major cause or causes.

After reading Mr. Snyder's paper, Dr. Persons called attention to the influence of the tremendous amount of hoarding of money which has recently been going on in the United States and in other countries. In this country, it amounts to perhaps a billion or a billion and a half of dollars. Obviously these hoarded dollars are doing no money work. While, originally, hoarding was the effect of the depression, it has now become a causal factor of the first magnitude.

The speaker stressed the fact that, in this country, hoarding is entirely unnecessary, for, at the present time, securities and commodities can be purchased at bargain prices. Furthermore, the United States Postal Savings Banks furnish almost absolute safety for those who fear to risk their funds in other banks.

The second speaker of the evening was Professor Irving Fisher of Yale University. He pointed out that, since the United States is on a gold standard, the value of gold cannot be dissociated from the value of money and credit. The value of gold has increased recently mainly because the value of the dollar has gone up. In early times, most of our dollars consisted of gold or silver. Now, however, the majority of them are merely deposits in banks.

The fundamental cause of distress today is the over-indebtedness incurred by the American people two years or more ago. We went into debt for radios, automobiles, houses, and stocks. Our per capita debt in 1929 was probably the greatest in history. When the indebtedness was paid off, the volume of our deposit currency was thereby reduced. Whenever the debt structure within a nation is unduly inflated, it is likely to collapse like a house of cards. In 1929 it happened to be the Hatry failure which sent the cards tumbling.

Under ordinary conditions, we sell goods because of a high price. However, when the price level is falling, thousands of persons are forced to sell goods because of low prices. The lower the prices become, the more they are forced to sell. This phenomenon of "distress-selling" is one which is not adequately discussed in economic textbooks.

When prices fall sharply, people do not take advantage of the low prices to buy, the main reason being that they have no funds. Though the debtor sells and pays off part of his indebtedness, it often happens that he continually keeps getting deeper and deeper in debt, for the dollars which he owes are becoming more valuable. Thus, although England has been making payments on her indebtedness to the United States ever since 1925, it would now take 45 per cent more goods to pay off her debt than it would have done in 1925.

As debtors liquidate their debts, they decrease the amount of deposits and hence the amount of our circulating medium. The idea that liquidation should be allowed to go on to the bitter end is thoroughly unsound. It represents the philosophy of helplessness. Under no circumstances should the vicious spiral of Debt, Distress-selling, and Deflation, be allowed to continue until the depression wears itself out. The present situation cannot legitimately be considered as a normal corrective for the over-expansion of 1929. Our present situation is far more abnormal than that of 1929. Deflation and falling prices always breed trouble in a society managed by entrepreneurs, for when their profits turn to losses, they curtail their activities, thus producing unemployment, and this unemployment reduces the national income. This fall in income makes prices fall still further.

Just as in 1919–1920, the Federal Reserve System has failed to protect the nation against a decline in prices. True, there has been put into circulation some $700,000,000, but this has not been enough. It came so late that hoarding had started and absorbed it all. There has been hesitation and, at present, efforts at stabilization have apparently been abandoned. Yet, it is unnecessary for the decline to continue further, for there are available at least two well-defined means of halting it. President Hoover has made an admirable beginning through his moratorium and his rediscount pool. The Federal Reserve System should, I believe, continue its open-market operations.

To eliminate this depression we need a rise in the price level. To raise the price level to normal and then keep it there should be the goal of our efforts.

The third speaker of the evening was Dr. Lionel D. Edie, Economist of the American Capital Corporation. He pointed out that deflation has its origin in inflation; that a certain amount of corrective deflation is desirable, but that destructive deflation, such as we have had with us during the last year, is demoralizing and has nothing to commend it.

The causes for the present depression may be classed as: (1) industrial, (2) political, (3) monetary. Under the first heading may be noted the fact that, in the case of a few staple commodities, there was over-production. Among the political causes may be mentioned excessive tariffs tending to interfere with the flow of international payments. Among monetary causes the most important was excessive lending. While these three causes, combined, doubtless made necessary a minor decline in prices and business activity, they did not necessitate the destructive phases which we have recently witnessed. These destructive phases have been caused by the sharp decline in the price level. This decline could have been stopped had the central banks of the world used their available powers to stamp out the conflagration. Their philosophy, however, has been "Let the fire burn itself out."

The important rôle played by the supply of money and circulating medium is clearly demonstrated by the similarity in the extent of the respective declines of the total volume of demand deposits outside speculative centers and the level of commodity prices at wholesale. This similarity is made more obvious when demand deposits (outside New York City) are adjusted in such a way as to eliminate the trend.

The supply of gold in the Treasury and in the Federal Reserve Banks has recently amounted to nearly $5,000,000,000. Only about $400,000,000 of this has been required to support that credit superstructure of member bank deposits outside New York City which, in the main, determines the price level, in other words, the deposit currency, which does nine-tenths of the money work of the nation. The remainder of this great gold reserve is used to back the hand-to-hand money which does but one-tenth of the total money work. The surest way to combat deflation is to shift gold from the use in which it is inefficient to the use in which it is highly efficient.

We are often told that depressions like the present one are necessary to wipe out weak concerns. If we actually believe in complete liquidation, we should not follow the illogical practice of using government aid to protect weak concerns at a time like the present.

The truth is that destructive deflation is unnecessary. The central banks could have prevented this type of deflation by forcing larger reserves upon the member banks. The probabilities are that, if the central banks had used no more than $200,000,000 in gold at the right time and in the right place, they might have turned the price level upward.

There are two ways in which the deflation may be ended. First, by some accidental occurrence as, for example, war or crop shortage. Second, by deliberate action on the part of the authorities responsible for the credit facilities of the nation. The latter method is, of course, much more desirable and dependable. The organization of the National Credit Corporation is a step in the right direction. Nevertheless, since the plan for it has been announced, deposits have continued to shrink at a rate which, if continued, would amount to $4,000,000,000 per annum. It is by no means impossible that such a shrinkage may more than offset the amount of good done by the National Credit Corporation.

The probabilities are that if the central banks do not use their powers to stop the deflation movement, the more radical forces of the nation will institute their own measures for raising prices to higher levels, measures which may, in the end, lead to undue inflation and, therefore, be extremely dangerous.

The last speaker on the regular program was Professor Edwin W. Kemmerer of Princeton University. He pointed out that, between 1873 and 1897, the world was suffering from gold scarcity and that it was this gold shortage which caused the widespread demand for bi-metallism. The gold shortage was terminated by discoveries of this metal in the Klondike and South Africa. The influx of new gold from these regions caused wholesale prices to rise between 1897 and 1913 at a rate of about 2.6 per cent per annum. It was, however, between 1913 and 1920 that prices climbed very rapidly. This ascent happened at a time when gold production was actually falling off. Obviously, therefore, it was due to causes other than gold supply.

The two forces really responsible for it were, first, the establishment of the Federal Reserve System—a system which made the gold dollar in the United States do much more money work than before; second, the World War. The War's influence on the price level was due to the fact that, throughout a large part of the civilized world, paper money was substituted for gold. Furthermore, the velocity of the circulation of bank deposits increased greatly while the physical volume of business increased but slowly. In the United States we issued Liberty Bonds in great quantities and everyone was adjured to borrow and buy. The Federal Reserve banks loaned vast amounts of money on the security of these bonds, thus greatly increasing the total circulating medium. This large volume of credit resulted in inflated prices.

The price collapse in 1920 was due to the deflation of this credit balloon. This deflation was severe in the United States but was more disastrous in Europe.

The indications are that, in 1929, there was, in this country, no particular inflation in the prices of commodities in general. Had there been no war and had prices continued to increase from 1913 to 1929 at the pre-war rate of 2.6 per cent per annum, prices would have averaged about as high for the period 1922–1929 as they actually did.

Now, wholesale prices have again fallen to the 1913 level. This decline cannot legitimately be ascribed either to shortage of gold or to maldistribution of gold, for the world stock of monetary gold has increased at the average rate of about 3½ per cent per annum since 1921, which is faster than the normal annual rate of increase of physical productivity of basic commodities among advanced countries, calculated at 3 per cent by Carl Snyder. During these years of post-war readjustment the rate—this average rate of growth of physical productivity—fell well below this figure. As a matter of fact, it is not at all necessary that gold should increase as rapidly as business for it is perfectly feasible, through improved currency and banking devices and increasing rates of monetary and deposit turnover to make each ounce of gold do more and more money work.

If the recent price decline had been due to an insufficient supply of gold, it would doubtless have manifested itself by a slow downward trend rather than by a cataclysmic drop like that occurring in 1920 or like that of 1930–1931.

Furthermore, there is no particular reason to feel that the present price decline has been caused by an excessive accumulation of gold in the United States. True, we have a very large proportion of the total world supply but we need a large proportion because we transact an extremely large fraction of the business of the world. In proportion to the volume of business done, France now has much more gold than we have.

As a matter of fact, gold has flowed to the United States not because we wanted it, for it has come without any intent on our part. Our tariff policy is also partly responsible for our large gold holdings.

The principal reason why gold has flowed into the United States has, however, not been the tariff but the fact that many are following the policy of "safety first." People have been selling doubtful assets for what they would bring in terms of gold exchange and have sent the funds thus obtained to the United States or France where they believed that their money would be safe and that they could obtain gold whenever they desired it. Instead of encouraging gold to come to the United States, the Federal Reserve banks have actually discouraged the movement by keeping their rediscount rates low.

One of the main reasons why prices have fallen is that the velocity of circulation of demand deposits in our banks has diminished greatly. In 1929, for example, the actual rate of circulation in New York City was approximately 133; in August, 1931, it had been reduced to 36. When people expect prices to go lower, they tend to hoard not only money but bank deposits as well. As soon as confidence is restored, this hoarding process will doubtless stop and the velocity of circulation will increase rapidly. Our greatest need at the present time is a psychological one—a restoration of confidence. For the future it is to have the management of the currencies of the world placed in the hands of competent men; and to have these men coöperate in managing them in a scientific manner.

After the close of Professor Kemmerer's remarks, the meeting was opened for general discussion. Dr. Woodlief Thomas expressed substantial agreement with the view of the speakers that the present depression was largely brought on by the growing volume of debt and the expansion in business and speculative activity which preceded. He stated that the method offered by most of the speakers for remedying the depression, namely the creation of more debt which would increase the purchasing power and hence prices, raised two questions: (1) Since the expansion of credit from 1922 to 1927 did not cause a rise in prices, what assurance have we that new expansion will result in such a rise? (2) What are the factors that cause credit to be used? There is at present no shortage of available banking resources. They are as large, if not larger, than they were in 1927 and 1928; yet the extent to which credit is used in business transactions is much smaller. Must there not be some motivation on the part of business men? New funds made available by reserve bank purchases of securities and through bonus payments to the veterans have been largely used in the first instance to buy government securities, and in the second instance to pay old debts. The rôle of volume of bank credit has been emphasized while the influence of velocity, which reflects the use that is made of credit, has been ignored.

The discussion was closed by Professor Schulze-Gävernitz of the Universities of Freiburg and Berlin. He expressed the view that, while we have used the brains which God has given us in the natural sciences, we have made but little use of them in the social sciences, and that this is especially true in the fields of currency and credit. In his opinion, the world depression was by no means unavoidable, but could have been avoided had appropriate action been taken by the proper authorities.

However, it is no use to worry about the past. The important question is what to do now. Obviously, in times like the present, when confidence is lacking, it does no good to lower interest rates, for those who have proper security will not borrow and those who do not have it cannot borrow. Under such circumstances, we need to use more drastic remedies. The easiest remedial measure is to reduce the purchasing power of money, in other words, to increase commodity prices. This can be done in the United States without destroying the gold standard, for the United States has, at present, abundant gold reserves. Eventually, doubtless, the gold standard is destined to disappear, but the time is not yet ripe for that. For the present emergency, the great thing is to create additional purchasing power by means of currency.

Radical action to eliminate unemployment is imperative. Public relief is better than nothing but public employment is much better than public relief. This public employment might be the way to bring more money into circulation, thus overcoming deflation.

To illustrate how desperate the condition has become in Europe, the speaker quoted Montague Norman, Governor of the Bank of England, as saying that if the present depression is not overcome within a year, capitalism may be wiped out. Europe is not now strong enough to turn the tide. America is in far better position to take the lead.

The meeting adjourned.

WILLFORD I. KING, *Secretary*

FINANCIAL LIQUIDATION AND RECOVERY

A dinner meeting of the American Statistical Association was held on Tuesday, November 24, 1931, at the Aldine Club, 200 Fifth Avenue, New York City. Three hundred and twenty persons were in attendance. Dr. W. Randolph Burgess, Deputy Governor of the Federal Reserve Bank of New York, presided. The general topic under discussion was "Financial Liquidation and Recovery."

The first speaker of the evening was Mr. John E. Rovensky, Vice-Chairman of the Bank of America, who spoke on "Some of the Proposed Changes in Our Financial Machinery." Mr. Rovensky called attention to the fact that every crisis brings forth a great number of financial doctors, and a correspondingly long list of proposed remedies, many of them entirely unsound, and most of them so radical that their application would result in a greater degree of maladjustment than that from which our economic organization is now suffering.

Mr. Rovensky expressed the view that there is no rapid cure for our fundamental trouble—the feeling of poverty which so generally prevails throughout our country, and which persists in spite of the fact that people are still in possession of the same material goods as formerly.

He also stated that, in his opinion, the proposal to find a corrective in our present situation in drastic changes in the Federal Reserve System would be a step in the wrong direction, although he felt that some slight broadening of the Federal Reserve Act might be effected without harm. This, however, he held might be accomplished more safely through the regulations of the Federal Reserve Board, than through legislative action which might open the way to dangerous tampering with the Act.

Some legitimate needs of our financial machinery, Mr. Rovensky stated, had been indicated by recent developments, but he felt that remedies for such ills should be sought outside the banks of issue. Our banking machinery probably ought to include some recognition of security or Lombard loans, and also of real estate loans.

President Hoover's plan for aiding banks holding a large percentage of real estate loans, through the formation of twelve regional Home Loan Discount Banks, in Mr. Rovensky's opinion, has much to commend it. An alternative plan, he stated, might be the utilization of existing Federal Land Banks for the same purpose. In any circumstances, the system should be so managed that it would not become an outlet or dumping ground for large amounts of immobile real estate loans.

"In the field of security or Lombard loans," Mr. Rovensky continued, "the National Credit Corporation gives every indication of being the agency that will meet most of the important requirements of the present situation. I hope that it will develop into a permanent part of our banking structure, a sort of national clearing house association, which, by pooling the resources of associated banks would, in time of special need, mobilize this credit which is not and ought not to be eligible for rediscount with the Federal Reserve Banks."

The second speaker of the evening was Dr. Warren M. Persons, Consulting Economist of Standard Statistics and other industrial and financial companies.

He began his remarks by pointing out that both debtors and creditors have lost heavily during the last two years. It is not surprising, therefore, that many individuals have felt it desirable, in view of numerous bank suspensions and the prospect of other ones, to accumulate as much cash as possible, and to put this cash into their safe deposit boxes. The individual, whether a person, corporation or bank, is nearly helpless in the face of the conditions which have arisen. We must act coöperatively or through the government if we are to break the evil spiral of deflation.

Those suggesting remedies for the depression may, like medical men, be divided into homeopaths and allopaths. The former contend that "like cures like," and hence that the remedy for deflation is more deflation, for unemployment is more unemployment, for liquidation is more liquidation. This school of thinkers, holding that we are the helpless victims of an economic machine which we are powerless to control, believes that we must either let the depression work itself out to its inevitable end, or adopt means to accelerate liquidation.

Dr. Persons definitely aligned himself with the allopaths. He held that much can be done to lift us out of the depression. Among the measures which he considers necessary are the following:

1. To adopt an enlightened treatment of those foreigners who are indebted to us on private or governmental account.
2. To adjust our tariff in such a way as to enable foreign debtors to pay us in goods, would contribute to our interests as well as to those of our debtors.
3. To attack directly the prevailing lack of confidence by suggesting safe or profitable uses for funds on hand.
4. To attack the causes of lack of confidence intelligently, vigorously, and in good faith.
5. To prevail upon the banks and the Federal Reserve System to coöperate in utilizing currency retained by hoarders as a basis for expanding the volume of credit. This can be done without going off of the gold base. Abandonment of the gold standard is dangerous because it might lead to extreme inflation and, should this happen, the remedy might be worse than the disease. Some inflation, however, when one has a flat tire, is necessary if the business vehicle is to proceed on its journey. Under these circumstances no obnoxious meaning should be attached to the word.

The third speaker of the evening was Mr. Robert B. Warren, of Case, Pomeroy, and Company. His topic was "After the Gold Exchange Standard, What?" Mr. Warren pointed out that it is difficult to find an instance in which a nation constantly on the gold standard has experienced price fluctuations as great as those occurring in the United States during the last seventeen years. One of the most important factors affecting the price situation during recent months has been the collapse of the gold exchange standard, the standard which, after 1922, became the basis of a large part of the currency of the world.

Previous to the great War, money was essentially gold coin or gold certificates, accompanied by a larger or smaller fiduciary issue. The central banks had functions which were decidedly limited. The chief reason for allowing them to issue bank notes was to save the trouble of carrying about gold coin, to regulate the flow of international funds, and to provide a measure of elasticity in seasonal or cyclical periods of strain.

The gold exchange standard in Europe originated primarily at the Genoa Conference which recommended the system as a means of economizing in the use of gold. The essential feature of the gold exchange standard was that central banks were permitted to count as gold reserves their balances held in the banks of nations actually on a gold or gold bullion standard as, for example, in the banks of the United States or Great Britain. The result of this arrangement was to make possible an enormous expansion in the volume of currency, and to cause a concentration of international demand liabilities in such gold centers. Under this arrangement it was possible for one dollar of gold in the Federal Reserve Bank of New York to cover as much as $720 in foreign deposit currency. The late Governor Benjamin Strong referred facetiously to it as a "gold tipped standard."

One of the chief weaknesses of the gold exchange standard was that responsibility for its maintenance was never definitely allocated or recognized. The banks of London, for example, never gathered reserves adequate to cover the demand deposits of foreign central banks. These demand deposits grew to huge amounts. For example, in 1927, the Bank of France alone was in a position to call upon the London market for an amount in gold probably equal to the entire gold stocks of England, and several times the actual gold in the banking department of the Bank of England. When, a few months ago, the foreign banks began to draw upon London, the British banks were unable to meet the strain, and Great Britain was, therefore, compelled to abandon the gold standard. This abandonment automatically placed a large part of the world upon a paper standard. The probabilities are that the gold exchange standard is now dead.

The world requires a common international standard. A number of countries are now talking seriously of establishing managed currency. There is, however, little prospect of the world's accepting such an international standard of value. It is impossible to go back to the true gold standard, for many countries do not have a large enough gold supply to make this feasible; but, with a different distribution of gold stocks, an international gold bullion standard might be practicable. In the event this proves impossible, it might be advisable to make silver once again part of the basic money of the world by the adoption of international bi-metalism or symmetalism. The advantage of adopting such a broad metallic base would be to make paper money once more redeemable in precious metal on demand, which is impossible under the gold bullion standard.

The fourth regular speaker of the evening was Alexander Sachs, Economist and Director of the Lehman Corporation, who dealt with the topic "The Rôle and Responsibility of Academic Delusion in the Depression."

Mr. Sachs began by pointing out that, during the period immediately preceding the crash, statistical economists had been placing undue stress upon interest rates and monetary factors as being the primary determinants of the business cycle. In 1929, for example, it was the general opinion that the Federal Reserve System had discovered and was putting into effect a satisfactory method of eliminating extreme cyclical movements. It was also widely believed that low interest rates could be depended upon to stimulate business activities. The result was almost universal confidence that no serious depression was likely to occur in the immediate future.

There was also a strong tendency among statisticians to put their trust in trend lines. Unfortunately, they overlooked the fact that many of the upward trends were the effects of a period of abnormal growth characterizing new industries. The fact that the products of these new industries such as, for example, automobiles, tires, refrigerators, etc., were being improved in such a manner as to give a steady increase in durability was too commonly overlooked, and hence it was not realized that, in the near future, we would inevitably meet with a falling demand for these products. Furthermore, little note was taken of the fact that the railroad industry was being undermined by the construction of cross-country gas mains, high power electric lines, and concrete highways. Under the circumstances, it is not surprising that most of the predictions went wrong.

Mr. Sachs expressed the further opinion that had statisticians and economists devoted more attention to the physical and technical phases of industry they would not have been so optimistic and would not have expected a revival of business early in 1930. Had they understood the real situation during the boom, they would have insisted on the building up of reserves and, when depression began, they would have urged the speeding up, rather than the postponement, of liquidation.

The last regular speaker on the program was Mr. Dwight C. Rose, Investment Counsellor, who dealt with the subject "Common Stocks at the Current Price Level." He opened by calling attention to the fact that, in December, 1928, at a meeting of the American Statistical Association, he analyzed several major factors influencing the price level of common stocks. From a consideration of these factors at that time, he concluded that, unless we were confronted with an entirely new set of conditions that no one could understand or explain on the basis of past experience, the then current level was dangerously high, and investors purchasing stocks at that time stood to lose anywhere up to 50 per cent of their purchase price.

Mr. Rose continued by pointing out that, first, last, and all the time, the market prices of common stocks are fundamentally dependent upon normal or prospective earnings, so we must look primarily to higher earnings in the future to justify higher stock prices. If earnings become lower instead of higher we must expect to see lower stock prices.

An analysis of the same factors discussed three years ago leads to the following suggestions:

1. On the generally recognized assumption that changing interest rates and changing commodity prices are directly reflected in the price level of common stocks, the threat which these two factors have offered to lower stock prices ever since the War has now been largely removed.
2. Over a long period of years, the most important factor influencing the price level of common stocks has been the accumulated earnings plowed back to

expand or improve the productive facilities of corporations. But these expanded productive facilities cannot, in this depressed period, find a market for their increased capacity. If, however, the capitalistic system continues essentially as we have known it in the past, it is reasonable to anticipate that the inherent characteristic of the people of the world to strive to maintain and improve their standard of living will again assert itself in a restoration of the *volume* of demand for goods and services sufficient to utilize most of the productive facilities that have been developed in this country over the past 31 years.

3. An increased volume of production, however, cannot by itself provide increased corporate earnings; the prices at which those products are sold also have a primary influence on earnings.

   If industrial common stocks were worth approximately the prices for which they were selling in 1901, the compound effect of actual earnings plowed back would have been to increase their equity value from 100 in 1901 to 630 in 1931.

   If we chose to deflate these reinvested earnings to 1901 commodity prices (the lowest level reached throughout the 31 years), the equity in our industrial stocks would have been increased to only 330. If, however, we conclude that commodity prices are more likely to become stabilized around current levels (approximately the level of 1913) the reflection of reinvested earnings deflated to 1913 commodity prices would result in a present equity value in our industrial stocks of 450, as compared with a current market price of about 270.

Perhaps a conservative suggestion would be that, as we pass through the revival stage of this cycle, we should have a restoration of demand for goods at approximately the present level of commodity prices. If this were reflected in common stock prices, it would mean an appreciation of more than 50 per cent from present levels, although they may, of course, continue lower in the meantime. If and when we enter the expansion stage after this revival, a further appreciation of 50 per cent might be anticipated, making a total appreciation above present prices of approximately 125 per cent.

The discussion was led by Mr. Sherwin C. Badger, of Barron's Magazine. He questioned the validity of the theory that deflation consists of a never-ending downward spiral in which each new adjustment creates the necessity for other adjustments. He cited as an encouraging sign the fact that wholesale commodity prices had been held fairly steady for several months which suggested that perhaps deflation in that particular area had been about completed. The question arose, he said, as to whether we should attempt by some broad plan to restore public confidence rather than to concentrate on removing or correcting the factors which were causing lack of confidence.

There is some doubt whether confidence can be restored until the basic causes for non-confidence have been remedied. The best policy is to face the real issues that concern us. We need drastic action in connection with international payments and reparations and the system of tariff walls which have been built up between the nations and which are still rising. We cannot afford to ignore our public debt.

He cited, as an example, the wholesale manner in which public borrowing has gone on to build an enormous system of highways, regardless of the economic return, and pointed out that in the course of this construction we had built up a competitor of the railroads which was wrecking one of our largest and most stable industries.

The discussion was continued by Mr. Vicker. He held that the first essential in getting out of the depression was to allay existing fear. To do this, our financial institutions must be put on sound bases. They could be greatly helped if all reparations and war debts were to be wiped off the slate.

At this point, Mr. Fales stated that he felt there was entirely too much tendency to charge our ills to the reparations question and to forget that France had good reason for demanding that Germany pay her debts. He also pointed out that what Germany has actually done to date has been to borrow, from the United States and elsewhere, all the money that she has paid out.

The meeting adjourned.

WILLFORD I. KING, *Secretary*

PROGRESS OF WORK IN THE CENSUS BUREAU

LIMITING THE EDITION OF CENSUS REPORTS

The Bureau has now entered upon the last year of the three-year census period which began on January 1, 1930,[1] and will therefore terminate on December 31, 1932. Of the $39,000,000 appropriated to cover the cost of the Fifteenth Census and that of the current work of the Census Bureau during the census period, only about $5,000,000 remained unexpended on the first of January. A short time before that a careful estimate had been made of the cost of printing 1,000 copies each of the reports and bulletins that were still to be published and the total reached the tidy sum of $1,075,000. In view of this situation it may prove necessary to limit the editions of all census publications from now on to the 1,000 copies provided for in the estimate above referred to. This will be hardly more than sufficient to supply the principal public and university or college libraries in the United States.

Additional copies of each report or bulletin will be printed for sale by the Superintendent of Documents, the Bureau itself not being allowed to sell its publications. The price which the Superintendent of Documents places upon the census publications is hardly more than enough to cover cost of press work, paper, and binding. For the final reports it will range probably from $2.00 to $3.00 a volume depending of course upon the number of pages.

This necessity of limiting the size of the editions printed by the Bureau for gratuitous distribution results from the fact that after the estimates for the appropriations were made and approved the scope of the work of the Bureau was considerably extended, particularly by the addition of unemployment to the subjects covered by the main census and by the special census of unemployment which was taken in January, 1931.

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[1] Erroneously stated as July 1, 1929, in the December issue of this JOURNAL (p. 466).

Eight series of state bulletins or reports covering the following subjects have already been completed and printed: (1) Population, minor civil divisions; (2) Population, composition and characteristics; (3) Unemployment; (4) Agriculture, minor civil divisions; (5) Agriculture, detail by counties, first series and (6) second series; (7) Irrigation; and (8) Drainage. Fairly large editions of these bulletins were printed and the supply on hand will probably be sufficient to answer all reasonable demands for these publications.

The series of state bulletins not yet completed—some of them in fact hardly more than begun—include the one on occupations, the one on families, the one on "type of farm," three on the census of distribution covering respectively wholesale trade, retail trade, and construction, and the one on manufactures. The reports of the census of manufactures include also a series of industry reports now in process of publication.

CENSUS OF RELIEF EXPENDITURES

The Bureau of the Census with the assistance of the United States Children's Bureau and the Department of Statistics of the Russell Sage Foundation recently completed a compilation of statistics on relief extended to families outside of institutions and to homeless men by governmental and private organizations in cities and other incorporated places, and also by county governments. This inquiry, which was undertaken at the request and under the auspices of the President's Organization on Unemployment Relief, covered the first three months of the year 1929 and the first three months of the year 1931. Since the earlier period was one in which industrial conditions were good, while the later period represented probably the peak relief load for any three-month period up to the time when the inquiry was begun in August, 1931, it was believed that the increase would furnish a basis for estimating the amount of relief chargeable to the business depression in the areas and for the period covered by the inquiry.

The inquiry did not cover relief given by fraternal organizations, individual church organizations, or welfare departments of industries. Nor did it cover relief by individual schools or school relief unless it represented a considerable share of the total relief in the community. Otherwise it covered all relief by governmental or private organizations, except that the figures for counties included only the relief extended by the county governments.

Returns were received from all of the 93 cities of 100,000 inhabitants or more; from all but one of the 217 cities of from 30,000 to 100,000; from 4,863 out of 5,938 cities or incorporated places of from 1,000 to 30,000; and from 6,353 smaller incorporated places.

The cities and other incorporated places from which reports were received comprise 89.2 per cent of the total population living in cities and incorporated places and 57.4 per cent of the total population of the United States.

The expenditures for relief in the incorporated places for which reports were received, together with the relief expenditures by county governments as reported, increased from $22,338,144 during the first three months of 1929 to $73,757,300 during the same months of 1931, an increase of 230 per cent

MOVING TO NEW DEPARTMENT BUILDING

The new building for the Department of Commerce, designed to accommodate all the Bureaus in the Department with the exception of the Bureau of Standards, has been completed and was ready for occupancy on the first of January. Three divisions of the Census Bureau—the Division of Vital Statistics, that of Financial Statistics of Cities, and the Geographer's Division—have moved into the new building, but the other divisions, including all those engaged mainly on Fifteenth Census work, and also the administrative division, which includes the offices of the Director, Assistant Director, and Chief Clerk, will remain in their present temporary quarters for some months to come and possibly until the end of the current year.

J. A. H.

MISCELLANEOUS NOTES

Error in the December, 1931, Issue.—The Officers' Page, as printed in the December, 1931, issue consisted of the official list as of December, 1930. The correct list of officers will be found in the September, 1931, issue of this JOURNAL, and also in the 1932 issue of the *Proceedings of the American Statistical Association.*

The error occurred at the Press after all proof had been read both by the Editorial Office and the printer, and consisted of the substitution of the wrong page at the time that the forms were locked. This was discovered only after the entire issue had been mailed.—THE EDITOR.

The Albany Chapter.—The Albany Chapter of the American Statistical Association has organized two classes in elementary statistics, primarily for the benefit of Civil Service employees. The total enrollment is 92. These classes are given under the auspices of the Chapter by Mr. Sidney W. Wilcox, Chief Statistician of the New York State Department of Labor, formerly Professor of Statistics at the University of Pittsburgh.

The last dinner meeting of the Chapter was held on December 9, 1931, at which meeting Miss Clara Parsons of the New York State Department of Correction presented a paper entitled "Fingerprints," and Mr. Frank Leonard, also of the New York State Department of Correction, talked on "Program of the Department of Correction in Respect to Criminal Statistics."

The Boston Chapter.—A joint meeting of the Boston Chapters of the American Statistical Association and the National Association of Cost Accountants was held at the Boston Chamber of Commerce on Wednesday evening, December 16, 1931. Dinner was served at 6.30 P.M. There were 122 members and guests present at the dinner, and 222 at the speaking session.

Mr. Leroy D. Peavey, President of the Boston Chapter of the American Statistical Association, presided.

Dr. David Friday, Consulting Economist, Washington, D. C., was the first speaker, and the subject of his address was "Economic Changes in the Present Financial Readjustment." His greatest emphasis was on the need for the investigation of our financial structure. He pointed to the failure of some 9,000 banks since the end of the War in striking contrast with the few failures prewar when banks were earning in the neighborhood of 7½ per cent. Most of these banks were located in the West and South. The decline in prices, particularly land values, and the reduced importance of farming with the consequent decline in farm products, etc., was pointed out as the principal cause of these failures. Dr. Friday referred to the extraordinary similarity of price curves in each of the three principal postwar booms—following the Napoleonic, the Civil, and the World War.

He analyzed the changes in land values, the shift into suburban areas at the cost of more central locations, and made a hopeful comment on the urgent necessity for expansive reorganization of traffic facilities in the large cities. As to the railroads, as soon as traffic comes back in any appreciable volume they will make big profits, so Dr. Friday maintained. Increased efficiency has enabled the railroads to handle a larger volume of traffic with steadily declining personnel, 1920–1929; also, rail rates went down where the earnings went up. Air travel he did not consider to be a serious menace to the older forms of transport.

Looking abroad, Dr. Friday expressed his admiration for the British economists and maintained that they were the only ones who might make a success of managed currency for not only Great Britain, but the British Empire—an integrating financial unit for the Empire as a whole. Colonies, he maintained, were of no economic advantage to a country. Germany's adaptation of American production methods assured her future. At the foundation she is economically sound. The Russian logic fails to alarm him. He figures that at best in 25 years they will not attain to a standard of living which could be rated more than 50 per cent of ours. War debts will be scaled down, if not cancelled. Figuring his share at $3.30, Dr. Friday said he would gladly forego that amount.

Mr. Joseph H. Barber of Boston discussed the topic, "The Arithmetic of Business Values." A summary of his address follows.

After all, essential needs and truths are always simple. It may help a little to set down some of these simple truths.

1. *You can't add* excess production to deficient demand without getting declining price valuations. Two years ago, we began to suspect this. Only today, after prices have fallen one-third, have we believed it enough to get production sufficiently down. Only in the fourth quarter of 1931 have we generally balanced current production against current effective demand and begun to reduce primary stocks on hand.

2. *You can't subtract* 101 cents from $1.00 and have any profit value left. In business it is net profit that is first to go. The net profit portion cannot be retained unless all the other parts are budgeted to their proper "number of cents" relationship to the total.

3. *You can't multiply* the same 25 per cent profit margin against a 33 per cent lower price level, and get the same dollars of income to cover overhead. Most managers are surprised when they inspect the ratio width of their current profit margin, to discover that its percentage to sales is practically as great as in 1928 and 1929. If their usual profit margin then was 25 per cent of sales, and if their margin is still 25 per cent of sales, then their margin is as wide now as can be hoped for in the future. Granted that price levels have declined roughly one-third, it must necessarily follow that the dollars of income for overheads will be reduced one-third.

In the face of this revised valuation for overhead allowances, there must be a definite readjustment of corporation overheads. Either (1) the individual salaries and expenses of the former personnel must be reduced 33 per cent, or (2) the personnel structure must be deflated by 33 per cent through eliminations, or (3) both individual salaries and the personnel structure must be deflated to result in a combined net saving of 33 per cent.

4. *You can't divide* 360 billion dollars of wealth into equal portions of a 5 billion dollar cash fund, without crashing valuations to 1/72 of their former valuations. The country's wealth itself comprises values. Most of those values are represented by sheets of paper—such as mortgages, bonds, stocks and commercial paper. While the valuations written upon these papers are expressed in terms of cash, the values themselves are intangible and normally rest upon a foundation of confidence.

In 1929 the country had roughly 360 billion dollars in wealth, as against only 5 billions in cash. Fear began to demand its pound of flesh. It wanted to see all its rights converted into cash. It demanded that 360 billion dollars of wealth become tangibly incarnated in the form of cash. But, since there is only a 5 billion dollar cash fund, complete liquidation into cash could only come about by crashing valuations down to only 1/72 of the former valuations. For many corporations, their full outstanding stock now has a quoted value no more than their actual cash. If the same processes continue as far in other economic matters, we would reach the limit of bread at 1 cent a loaf, shoes at 20 cents a pair, and coal at 50 cents a ton.

What has the Individual Manager Learned from Depression? In most businesses the net working capital equals only three months sales. This means that, during a period of stress, the working capital may be seriously impaired within six months. As a consequence, in a depression a business man is forced to look to the immediate future, and cannot personally attach very great weight to programs that do not promise speedy results.

The noted economist Wesley Mitchell has said that "the only normal condition of business is a constant state of change." The individual manager realizes this fully; and, as a consequence, he not only watches his working capital with an "eagle eye," but more particularly he watches the *changes* in his working capital. If he doesn't set himself up as the perpetual spy upon his working capital position, then he will soon find himself replaced and someone else will be watching it for him.

Finally, since the changes in working capital are all too quickly reflected in cash position, an individual's security depends upon his maintaining a liquid supply of cold cash.

Following the addresses by Dr. Friday and Mr. Barber, the meeting was open for discussion, in which a large number of those present participated. The meeting adjourned at 10.45 P.M.

ROSWELL F. PHELPS, *Secretary*

The Chicago Chapter.—On November 19, 1931, at the second dinner meeting of the season, with 55 in attendance, Mr. George E. Putnam, Manager of the Commercial Research Department of Swift and Company, spoke on the topic "What Can We Do About Depression? Is National Planning the Remedy?" Mr. Putnam outlined three causal doctrines for depression and the remedies that have been proposed: (1) Lack of business leadership, or inability to coördinate production and consumption. The remedy proposed is National Planning, but Mr. Putnam believes such planning could not be successfully operated under our present system of private enterprise. (2) Lack of leadership for uses of products; workers do not have sufficient purchasing power to buy products of industry, owing largely to profits taken by leaders. As a remedy for this, maintenance of wages, new building, etc., have been proposed, to create purchasing power. It was pointed out, however, that recent efforts along these lines have been failures. (3) Lack of credit control by the Federal Reserve System. But Mr. Putnam explained that the Federal Reserve has only been following rules of national policy, i.e., wanting war debts paid but no foreign goods. As a consequence, we are bound to get gold and promissory notes, thus breaking down foreign credit. We have done more than any other country to force other countries off the gold standard, and we now have no export market for our products. Mr. Putnam believes that the immediate cause for all depressions is to be found in human beings and their use of credit; when the supply of credit runs short, trouble starts. His remedy for depression would be a Supreme Economic Council for determining matters of national policy.

BERNICE LAMB, *Secretary*

The Cleveland Chapter.—The second meeting of the season was held on October 19. Mr. Russell Weisman of the Cleveland Plain Dealer gave a talk on bi-metallism in which he sketched the history of bi-metallism in this country and discussed what would probably happen if a bi-metallic system were set up in the United States at the present time.

The next meeting was on November 16. Colonel Leonard Ayres of the Cleveland Trust Company gave a talk on the business situation and on business prospects for next year.

The next meeting was on November 23. The Harvard Economic Conference was reviewed by the members who had been present, the discussion being led by Mr. Bradford B. Smith of the Cleveland Trust Company.

The fifth meeting took place on December 21. The address was given by Professor McPherson of Cleveland College, the subject being the German situation and outlook. Professor McPherson was in Germany during the summer of 1931.

D. C. ELLIOTT, *Secretary*

The Pittsburgh Chapter.—Throughout the year 1931 intensive interest has been shown at the monthly luncheon meetings at the Keystone Athletic Club. An average of 32 members was in attendance and the trend seems to be upward.

The 12-months group forecast, based on the Annalist Index of General Business Activity, is revised monthly and a new month added. Following the announcement of the revised figures the members are invited to recite their method of reasoning in making up the individual forecasts. Considerable benefit has been derived from this feature of the meetings as it is sure to bring out all phases of the business picture.

At the October 22 meeting Dr. George K. McCabe and Mr. Prentice N. Dean of the Finance Department of the University of Pittsburgh contributed by speaking on the causes and effects of the abandonment of the gold standard in England. The November 25 meeting was featured by Mr. A. C. Robinson, President, Peoples-Pittsburgh Trust Company, who spoke on the events leading up to the organization of the National Credit Corporation, and the functions and purpose of that institution. Mr. J. C. Nevin, Managing Director of the Pittsburgh Branch of the Federal Reserve Bank of Cleveland and Vice-President of the Pittsburgh Chapter, answered questions on the subject.

The speaker at the December 17 meeting was Mr. E. C. Stone, Assistant to the President, Philadelphia Company, who selected as his subject the timely question—"What Next?" Mr. Stone recently has been making a study of contemporaneous economic conditions, which has brought forth numerous tentative conclusions, and which were discussed fully. The key to these conclusions was as follows:

1. When the demand for goods and services becomes sufficiently urgent, the trend of business will turn upward.

2. As a foundation upon which increased demands will be built to create better business, the price levels in commodities, bonds, stocks and wages must be stabilized.
3. As time goes on substantial demands are building up through the operation of the factors of depreciation and obsolescence on existing fixed capital and through the progress of engineering development.
4. Increased demands from the people at large in any substantial volume cannot be expected under existing conditions.
5. Adequate information is not available upon which to base an opinion as to when the trend of business will turn upward.
6. Bank credit is a very powerful economic instrument about which there is yet much to be learned.

Subjects for future meetings have been tentatively announced by the Program Committee as follows: The Movement of Wholesale and Retail Prices; Plans for Stabilizing the Coal Industry; Merchandising the Business Cycle.

A. W. Lohr, *Assistant Secretary*

Philadelphia Statistics Group.—Two meetings of the Philadelphia Statistics Group were held during the fall and early winter. At a dinner meeting in November the topic, "The Financial Crises Abroad and Their Effects in the United States," was discussed. Robert B. Warren of Case, Pomeroy and Company, New York, talked on the financial situation in England, and Dr. Ralph Young of the Economics Department, Wharton School, University of Pennsylvania, traced the development of the crisis in Germany.

In December a symposium was held on methods of unemployment relief in Philadelphia. The speakers on this program, together with their special topics, were: Dr. W. N. Loucks, Assistant Professor of Economics, Wharton School, "Relief Through Public Works"; Emmett H. Welch, Unemployment Studies, Industrial Research Department, "Displacing Employed Married Women"; Roger F. Evans, Leeds and Northrup Company, "Prevention and Relief Through Individual Company Action"; Karl de Schweinitz, Executive Secretary, Community Council of Philadelphia, "Problem of Direct Relief: Public vs. Private."

The meetings of the Philadelphia Statistics Group are held on call at the Christian Association Building, University of Pennsylvania.

H. S. Davis

United States Bureau of Labor Statistics.—In January, 1932, the Bureau began the publication of a revised wholesale price index, which is being issued weekly as well as monthly. The new index carries 784 price entries, instead of 550 as before. For the most part, the additional items are the fully manufactured commodities, or the so-called "consumers' goods." The average for the year 1926 is continued as the price base, or 100, and all additional commodities have been priced back to that date. The monthly index is being computed separately as heretofore, but on the larger number of commodities, and is not an average of the weekly indexes.

A field study of relative costs of material and labor in building construction in several representative cities in the United States is now being made, the data being taken directly from the records of building contractors. The report will be similar to that issued by the Bureau on this subject early in 1929 for three cities. By correlating the data obtained in the present study with building permit figures, union wage rates in the building trades, and wholesale cost of building material, it will be possible to arrive at a fairly satisfactory index of building costs.

The results of the investigation of technological changes in the cigar industry and their effects upon employment, referred to in a previous issue of this JOURNAL, were published in the December, 1931, *Monthly Labor Review*. Similar studies are in progress for the telephone and telegraph, slaughtering and meat-packing, tanning, boot and shoe, electric light and power, lumber, and automobile-tire industries.

Summarizations of the data obtained by the Bureau on wages and hours in 1931 in foundries and machine shops, silk and rayon goods manufacturing, bituminous coal mining, and the iron and steel industry have been carried in recent issues of the *Monthly Labor Review*.

The study of hiring and separation methods in representative manufacturing plants of the United States is being continued.

The reports on volume of employment in the building industry, publication of which was begun by the Bureau early in 1931, are being constantly expanded, as is also the other regular work on volume of employment. Information on volume of employment is being published at present for 85 manufacturing industries and for 14 groups of non-manufacturing industries. Index numbers of employment and pay roll are given for 54 manufacturing industries and for 12 of the non-manufacturing groups.

Among the bulletins of the Bureau recently published are the 1931 edition of the *Handbook of Labor Statistics*, a study of labor conditions of women and children in Japan, and bulletins giving translations of the labor legislation of Ecuador, Paraguay, and Venezuela.

Women's Bureau, United States Department of Labor.—In August and September, 1930, the Women's Bureau conducted a survey of unemployment in South Bend, Indiana, and the adjoining town of Mishawaka. This community is important industrially in proportion to its size, it is representative of a number of different industries, and it is not too large for a house-to-house canvass of its industrial sections.

All told, 3,245 women reported on their employment status during the preceding 12 months and at the time of the survey. Information obtained through personal interviews with the women in their homes included age, marital status, country of birth, industry, employment history for the past five years, broken and irregular employment during the past 12 months, with changes in hours and earnings, and statements in regard to economic status and existing financial difficulties. Although just over one-third of the women had escaped lay-offs, of one week or longer, the others had lost an average of 6½ weeks per woman, 18 per cent (367 women) had been idle from two to six months, and 83 women had worked less than half the year. Some 1,700 women reported reduced earnings. Material was obtained also as to size of the family, total number of wage-earners earlier in the year and at time of survey, steadiness of employment, and economic difficulties. The number of families of two or more members reported upon was 2,576, comprising 11,316 persons.

It had been customary in these families for large proportions of the members to be gainfully occupied. At an earlier time within the 12 months only 219 families had been dependent upon one wage earner each, but at the time of the interview there were 765 in which only one person was working. For all but five of the latter, the relationship of the sole wage earner was learned; in 371 cases it was the husband or father, in 228 cases it was the wife or mother, in 120 cases it was a daughter, in 20 cases it was a sister or other woman, and in 21 cases it was a son or other man. In 134 families in which the husband was not employed, the wife was the sole wage earner. In about 100 cases a woman was the only person working in a family of five or more members.

In 89 families and 19 cases of women living alone, there was no wage earner, even part time, and in 1,214 cases, although there was some one at work, no one had a steady job.

Pay-roll figures from plant records show reduced hours and earnings. For example, certain establishments in three industries, largely clothing and footwear, reported the amounts paid to 2,746 women in September, 1929, the median being $17.80 for the week. In September, 1930, the number of women was 2,483 and the median was $13.35. At the earlier date, only 9.9 per cent of the women received less than $10; at the later date, 23.9 per cent did so. In the same period hours had been reduced, their medians being 45.1 for the week in September, 1929, and 39.2 for the week in September, 1930.

Field work and tabulation have been completed on a general survey of new methods of work and their effects on women workers in the cigar and cigarette industries.

In addition, two general handbooks on the best available standards and practices in regard to *The Installation and Maintenance of Toilet Facilities in Places of Employment*, and *The Lighting of Work Places* are in process.

The Bureau of Agricultural Economics.—A monthly mimeographed publication called "The Dairy Situation," prepared by a Dairy Statistics Committee in the Bureau of Agricultural Economics, was inaugurated with the September, 1931, issue. This report includes general comments on farm and factory production, the dairy feed situation, pasture and weather conditions, farm and market prices, market receipts, storage movements, foreign markets, etc. It is a general review of the dairy situation as a whole and is intended to be of use to persons connected with all branches of the industry.

As a result of a milk consumption survey conducted in Boston, and sponsored by the New England Research Council, the Bureau of Agricultural Economics, and other organizations, a report prepared by Mr. F. V. Waugh, Executive Secretary of the New England Research Council, was published in September, 1931, under the title "The Consumption of Milk and Dairy Products in Metropolitan Boston in December, 1930."

A mimeographed publication containing charts, by L. H. Bean of the Bureau of Agricultural Economics, is just off the press. This statement is entitled "Factors Related to Acreage, Production, and Prices of Potatoes in Florida," and is a summary of outlook talks presented to growers in LaCrosse and Hastings, Florida, in November, 1931.

The annual outlook conference was held by the Department of Agriculture in Washington, January 25–29, 1932, and the Agricultural Outlook report was released February 1, 1932.

The Canadian Census.—Provisional totals, by provinces, of the population of Canada according to the Census taken as of June 1, 1931, were announced by the Dominion Bureau of Statistics on November 30. The grand total for the Dominion was 10,353,778, an increase of 17.82 per cent over 1921. The largest absolute gain (509,128) was in the province of Quebec, but the rate of increase was greater in British Columbia and Alberta than in Quebec, viz., 31.38 per cent and 23.63 per cent respectively, compared with 21.56 per cent in Quebec. These results have been issued two months earlier than in any previous Census. The punching of the population cards for the final compilations will, it is hoped, be completed by March.

Statistics of Blindness.—A Committee on Statistics of the Blind, appointed in 1929 following a conference of workers for the blind and others interested in improvement of statistics relating to the blind, has prepared and published a proposed standard classification of causes of blindness, a proposed combination of scales for uniform classification of the blind according to amount of visual perception, and a proposed standard form for physicians' reports on eye examinations. This Committee consists of Dr. Franklin B. Royer, Association for Prevention of Blindness, New York; Miss Evelyn C. McKay, American Foundation for the Blind, New York; Stetson K. Ryan, Connecticut Board of Education of the Blind; Bennett Mead, United States Department of Justice, formerly of the Bureau of the Census, and Ralph G. Hurlin of the Russell Sage Foundation. Criticisms of the proposed classification, scale, and form are invited and copies may be obtained from the Secretary of the Committee, Miss McKay. A review of the work of this Committee to date was published in the December, 1931, issue of the *Outlook for the Blind.*

PERSONAL NOTES

Dr. Edmond E. Lincoln has been transferred from the International Telephone and Telegraph Corporation to the duPont Company, with headquarters in Wilmington. His work will be primarily with the Executive and Finance Committees.

Dr. Woodlief Thomas accompanied Dr. Walter W. Stewart to Basle in December to assist him in his work as the American member of the Special Advisory Committee convened by the Bank for International Settlements under the provisions of the Young Plan.

Dr. Louis Block has been appointed Secretary and Director of Surveys of the California State Unemployment Commission. He has been transferred to this commission from the California Department of Industrial Relations, where he has served as Statistician since 1922.

William Jaffé, Professor of Economics at Northwestern University, is to be in Paris during the summer of 1932 where he will conduct under the auspices of the University of Paris a Seminar in Social Science Research in Paris, from June 15 to July 31, 1932, for Americans interested in research in France.

MEMBERS ADDED SINCE DECEMBER, 1931

Amberg, Joshua L., Hyman and Company, 61 Broadway, New York City

Axel, Dr. Robert, Bureau of Jewish Social Research, 71 West 47 Street, New York City

Berets, Carl H., C. H. Berets and Company, Investment Bankers, 120 Wall Street, New York City

Baldwin, H. C., Editor-in-Chief, Babson Reports, Babson Statistical Organization, Wellesley Hills, Mass.

Barnhart, Lylo, Research Assistant, University of Illinois Bureau of Business Research, 205 Commerce Building, Champaign, Ill.

Bodman, Herbert L., President, New York Produce Exchange, 115 Produce Exchange Building, New York City

Brinton, Dr. Hugh P., Jr., President's Research Committee on Social Trends, Chapel Hill, N. C.

Britten, Rollo H., United States Public Health Service, Washington, D. C.
Brundage, Charles E., 50 Walker Road, West Orange, N. J.
Bucknam, Dr. Roland F., Public Service Commission, State Office Building, Albany, N. Y.
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Case, Walter S., President, Case, Pomeroy and Company, Inc., 120 Wall Street, New York City
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Coit, Charles G., Bankers Trust Company, 16 Wall Street, New York City
Cunningham, William H., State Mutual Life Insurance Company, Worcester, Mass.
Dunn, Edwin S., Moody's Investors Service, 65 Broadway, New York City
Dunn, Dr. Halbert L., Head of Statistical Division, Mayo Clinic, Rochester, Minn.
Eddy, Emerson W., Sales Analyst, Texas Gulf Sulphur Company, 75 East 45 Street, New York City
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Russell, Dr. James T., Examiner, Board of Examinations, University of Chicago, Chicago, Ill.

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Treloar, Professor Alan E., Department of Botany, University of Minnesota, Minneapolis, Minn.

Torrey, Dr. Marian M., Goucher College, Baltimore, Md.

Webb, John N., Instructor, Columbia University, Room 709, Hamilton Hall, New York City

Woodward, Donald B., Financial Editor, The Business Week, McGraw-Hill Publishing Company, 337 West 42 Street, New York City

REVIEWS

International Migrations, edited by Walter F. Willcox on behalf of the National Bureau of Economic Research. New York: National Bureau of Economic Research, Inc. 1929. 2 vols., 1112, 715 pp.

This study, financed by the Social Science Research Council and carried out under the direction of Professor Walter F. Willcox for the National Bureau of Economic Research, brings together the best available material on migration during the nineteenth century and the early part (until 1924) of the twentieth. It is divided into two distinct parts. Volume I deals with the statistics of migration and was prepared, under agreement with the International Labour Office, by Dr. Imre Ferenczi. Volume II consists of a series of papers by various scholars dealing with national immigration and emigration currents, Professor Willcox's introductory paper on world population being the only one not dealing directly with some phase of migration.

Clearly no review can do more than give the most meager notion of the contents and value of these volumes. Volume I seems to the reviewer to cover, as adequately as data and space permit, the actual movements of people across national frontiers during the period under consideration. The introductory and textual material, comprising about one-quarter of the volume, serves as a commentary on the tables given later and is useful to the student in a variety of ways: it gives a general survey of the movements which the tables set forth in more detail; it calls attention to the difficulties encountered and the limitations of the data; and it sets forth rather briefly the background of modern mass migration. However, it is to Volume II that one will turn for the understanding and interpretation of the data. This was the intention of Professor Willcox in planning the work.

Volume II is introduced by a study of the increase of world population since 1650 by Professor Willcox. To the reviewer this happens to be the most interesting part of the book. Although it does not directly deal with migration, it is certainly relevant to a study of world movements. Professor Willcox has brought together here a mass of information which all students of population will frequently use. The largest element of uncertainty in recent estimates of world population, Professor Willcox finds to be the probable size of China's population. In this the reviewer is in entire agreement with him but he finds himself unable to accept such a definite figure as Professor Willcox gives because of lack of confidence in the Chinese data. The difficulties of census taking in China are well-nigh incredible and the margin of error cannot but be very great.

All the papers dealing with particular migration currents are of interest, though by no means of equal worth. There is necessarily much repetition in them because, after all, the composition of immigrant and emigrant populations is much the same in most countries, and the causes which determine immigration and emigration are much the same in Argentina and the United States or in England and Italy.

The reviewer found Dr. Hersch's paper on the Jews of particular interest. It is the most comprehensive and thorough of these chapters. Several of the others would have been improved if the authors had had Dr. Hersch's before them as a model. Dr. Hersch has not only made his chapter a commentary on the statistical tables in Volume I but he has set forth clearly the characteristics—age, sex, occupation, and so forth—of Jewish migrants and the circumstances determining their movements.

Almost equally good is Dr. Ratti's chapter on the Italians. It will contribute not a little to the better understanding of the mass migration from Italy in recent decades.

The chapter on India deals largely with the difficulties Indian emigrants encounter abroad, shedding but little light on the conditions in India which might favor or discourage emigration. The chapter on Japan is unsatisfactory from the same standpoint and does little but discuss the validity of the statistics.

Several of the chapters on northwest European emigration, while good, add but little to the common knowledge of these movements. This is perhaps inevitable under the circumstances.

Certainly this work will prove indispensable to all those using migration statistics and will also prove enlightening to those with only a casual interest in human migration, although it does not touch upon many of the most important problems of migration which we shall have to face in the not-distant future.

WARREN S. THOMPSON

Research in Public Finance in Relation to Agriculture—Scope and Method, edited by John D. Black, and prepared under the direction of the Advisory Committee on Social and Economic Research in Agriculture. New York: Social Science Research Council, Bulletin No. 1. December, 1930. 174 pp.

This is a document which raises great expectations. It is the first bulletin of the Social Science Research Council, whose effort to contribute to the advancement of science is sponsored by seven learned societies, including the American Economic Association and the American Statistical Association. It deals with research in the field of public finance—a field of great difficulty and complexity and one in which the special interests of groups, even of academic groups, tend to distort the objectivity of research. The document addresses itself to certain problems of agriculture—problems which are the focal points of political controversy and which are claimed as the particular province of a group of students who have come to be known in recent years as agricultural economists. It is to assist this group and especially the numerous workers in the agricultural colleges who are in a position to undertake detailed researches that this present bulletin and others to follow have been prepared.

The statement of objectives (p. 3) reads as follows:

> The specific ends in view . . . were to mark off this field of agricultural economic research, outline its content, describe the research projects already undertaken in this field, point out additional projects which might be undertaken, review and evaluate the methodology employed in projects completed or under way, and suggest methods and procedures that may be used to advantage in different types of projects both old and new.

Truly this is an undertaking which is well-conceived and extremely promising of valuable results.

The report is admirably outlined. It begins with a series of introductory sections dealing with "objectives," "the field of research," "basic principles, concepts and measures," "history of research in public finance in relation to agriculture" and "sources of research data." The bulk of the book (150 of the 174 pages) is then devoted to a discussion of forty-five individual research projects grouped under ten headings. Credit for the general scheme of organization is assigned to a Special Advisory Committee constituted as follows: John D. Black (chairman), Eric Englund (executive secretary), M. S. Kendrick and R. W. Newton. This committee "met and drew up the general outline for the report, made suggestions as to persons to help with various parts of it, and finally approved it for publication."

A list of twenty-three contributors to the report is printed (p. 2), a list which contains the names of only two economists (Fred R. Fairchild and J. W. Martin) who are not prominently identified with the agricultural-economics group. Martin's contribution is an excellent statement regarding motor vehicle taxation (pp. 128–136). Fairchild is credited with having "read and criticised parts of this manuscript," with no indication as to the character of his criticism or the extent to which it was heeded. All the members of the Advisory Committee are listed as contributors, Kendrick collaborating in the discussion of one project, Newton being solely responsible for one project and collaborating on a second, and Englund being assigned no specific credit or responsibility. It is apparent that it was upon the shoulders of Chairman Black that the weight of the burden fell. His name appears in connection with no less than seventeen of the sections and projects. Professor Black has won for himself an enviable reputation as an agricultural economist, but, so far as the reviewer is aware, has previously evidenced no particular interest in problems of public finance. Next to Black the most active contributor was George Peterson, formerly with the federal Treasury and now with the Giannini Foundation (11 citations). The name of H. I. Richards, of the Harvard Committee on Economic Research, appears three times, and that of B. W. Allin of the federal Department of Agriculture appears twice. The other fifteen contributors were concerned with the discussion of single projects only. Clearly the report is essentially a product of the group of agricultural economists, and is to be accepted as their conception of the research problems of public finance as they affect the field of their special interest.

As is perhaps inevitable when the contributions come from so many individuals, the discussions of the projects vary widely in quality. Six of the forty-five projects are merely listed by title. Nine more are dismissed with a few words of comment. Two of the best, Martin's discussion of special motor vehicle taxation and Mort's discussion of a state plan for financing a minimum program of education, are already available in substance in easily accessible documents. Particularly interesting are C. C. Zimmerman's contribution regarding attitudes of the public and the Hibbard and Black analysis of the plan for taxing farm real estate on its annual net product. The first eight projects (Groups A and B), which are simple and predominantly descriptive in character, are fully and systematically developed. Undoubtedly they will prove helpful to agricultural economists undertaking tasks in this field. However, it is surprising how few of the projects demand the peculiar qualifications of an agricultural, as contrasted with a common or garden variety of economist.

Before one has read a dozen pages in this report he begins to be irritated and disturbed by the evidences of gross carelessness in its preparation. In a document which is designed to serve as a standard and guide for research workers, it seems especially desirable that reasonable standards of English form and of proof reading be observed. The frequent errors of grammar and punctuation suggest that the report may have been "dictated but not read." The following specific cases will serve to support the justice of this criticism.

On page 11, a dropped word makes John Stuart Mill responsible for the statement that "Governments generally do things less than private individuals!"

On page 14, the heading "3" and on page 18, the heading "4" should apparently be "C" and "D."

On page 21, appears this sentence: "This will point the way to the keeping of better records and the working out of more useful classifications and tabulations in the official annual reports, which is one of the most important functions which research in this field can perform."

Another dropped word on page 23 results in the statement that ". . . some of these studies have not been carefully enough made to discover the real meaning of some of the terms used and the pitfalls involved using the data."

Considerable ingenuity is needed to unscramble the following two sentences which appear on page 28: "Several states, like Massachusetts, publish reports which contain a consolidation of all local accounts in the other states. Recourse to more primary sources of information is a practical necessity if the entire field be covered."

On page 140, the citation (3) refers to a footnote on page 139. This sentence also appears: "The qualitative procedure will need to be a comparison of relatives prices of the products."

On page 160, Professor Adams is referred to as having made a presidential address before the "American Economics Association."

It is easy to over-emphasize the importance of such slips as these, but their presence in large numbers is certain to weaken the influence and to detract from the usefulness of the report.

Unfortunately, however, the shortcomings of the document are not confined to such minor blemishes. Thus the section headed "Basic principles, concepts and measures" starts bravely forth "to name, and in some instances also briefly to state or define, the principles or theories, concepts and measures that are involved in research in public finance in relation to agriculture" (p. 8). These are fair words but, when one reads critically the section headed "Public Finance" (pp. 14–18), irritation arising from lapses in form gives way to bewilderment and amazement. As an example of the quality of the presentation, consider the following excerpt (pp. 14–15):

> Agricultural economics [sic] working in the field of public finance are inclined to reason as if no taxes paid by farmers are shifted. They overlook the fact

> that there is probably a relationship between the division of ordinary taxes for road support between city and country and the prices at which farm products in the long run sell in urban markets. They also forget at times the probable shifting to agriculture of some of the taxes on railroad and industrial property.

Does the writer submit the last statement in support of the first, even though it concerns not a tax paid by the farmer and then shifted to others but rather a tax paid by a utility and then shifted to the farmer?

The following paragraph appears in the same section (p. 16): "Present discussion of bases of taxation is inclined to emphasize certainty and regularity of income considerably. This is, of course, an administrative criterion largely. Other writers stress diversity as desirable. A principal reason for diversity is that it means reaching more of the wealth and income of those able to pay." Diversity, largely, appears in this paragraph to have eliminated certainty and regularity, considerably!

The next paragraph plumbs the depths (p. 16):

> The question of the best bases for pro rating taxes should not be analyzed as an issue in social justice; but rather as one of who [sic] is in a position to support public activities with the least loss in his real net income. Obviously, those who have accumulated the most, or earned the most, either because of the help of government or not, are in the position named.

Indeed, this entire section reads like a literal transcript from the notebook of a sleepy student in a freshman lecture course. Terms are carelessly and loosely used (e.g., "base" on pages 15-17 and "property" and "land" in the second paragraph on page 15). Doubtful statements are set forth with unbecoming dogmatism. It is difficult to imagine what excuse there can be for the inclusion of material of this quality when there are good elementary texts in public finance freely available.

Judged by standards of what might be reasonably expected in a document of this character, the volume under review must indeed be pronounced a disappointment. A promising opportunity has been lost. If the book truly reflects the quality of the leadership in research among the agricultural economists, they must expect to be received as workers in the field of public finance with distrust and even apprehension. Students in this field are eager for new light from whatever direction it may be offered; to the agricultural economist, as interpreted in this volume, they raise the tragic Biblical lamentation: "But if the light in thee be darkness, how great is that darkness!"

ROBERT MURRAY HAIG

Columbia University

The Rôle of Agricultural Fluctuations in the Business Cycle, by Vladimir P. Timoshenko. Ann Arbor: The University of Michigan. 1930. 89 pp.

The purpose of this study is "to demonstrate how large a rôle agricultural fluctuations have played in initiating business cycles in this country." Had the author been a bit less ardent in the defense of his thesis and a bit more generous with unfavorable evidence, his arguments would have carried more conviction.

As it is, many of the conclusions, when subjected to close scrutiny, do not appear to be established beyond reasonable doubt.

In skeleton, Mr. Timoshenko's argument is as follows: There exist cycles of agricultural production in the United States, which, with some modifications from world crops, generate cycles of agricultural prices. Agricultural and industrial prices have somewhat similar cyclical movements, but due to the larger amplitude of the former and some dissimilarities of timing, the ratio of agricultural to industrial prices exhibits cyclical fluctuations. A low ratio generally coincides with or precedes recovery; a high ratio generally coincides with or precedes recession. Large crops and low prices of farm products are favorable to recovery because (a) they increase the profits of manufacturers using agricultural raw materials, (b) they increase the purchasing power of railroads, commission men and others handling farm produce, and (c) they reduce the food cost of living and increase the amounts consumers have available for expenditure on industrial products. Furthermore, big crops and low prices make for enlarged quantities and values of farm product exports and lead to a "favorable" balance of trade and gold imports. These gold imports bring about an expansion of money in circulation and of credit. Finally, a year-by-year comparison of business annals with the volume of farm production, the value of agricultural exports and the agricultural-industrial price ratio shows the dependence of the business cycle on these factors.

This train of arguments is vulnerable at several points. In the first place, the very existence of cycles in farm production is not adequately established. Just what is meant by cycles and what are the criteria for detecting them are crucial matters upon which we are not enlightened. Would the author maintain, for example, that there were cycles in an original series of random deviations if a two-year moving average of such deviations exhibited fairly marked cyclical movements (serial correlation = 0.5)? If not, he would have great difficulty in establishing the existence of cycles of crop production.

In support of the generalization that fluctuations in farm prices may be fully explained by variations in the volume of crops in the United States and abroad there is given a correlation of −0.734 between indexes of domestic prices and volume of crops, a chart of these series, and an explanation that the lack of relation in certain years was due to unusual foreign crop conditions. On the basis of this partial evidence the author concludes that "there is no necessity for any additional explanation of the cycles in agricultural prices revealed by the index of farm prices of ten leading crops." Apparently it is thought that cyclical fluctuations in consumers' incomes and in the prices of industrial commodities have a negligible influence on farm prices!

The reasoning with regard to the effects of large crops and a low agricultural-industrial price ratio in stimulating a recovery from depression is in part sound. Without doubt, relatively low raw-material costs and enlarged volume of operations in industries, merchandising, transporting, and processing farm products are, in themselves, favorable factors. Increased activity in these lines can cause expansion in other lines of business, especially if it involves additions to plant and equipment, i.e., the production of permanent capital goods. But there are restrictive effects of large crops and low prices which the author fails to discuss. If the farmer gets a smaller total return for his crop and the final consumers pay a larger total price for farm products, *ceteris paribus*, they have less of their incomes to spend on other industrial products. Of course, other things are not equal—and the ultimate question is whether the cumulative expansive effects finally outbalance the cumulative restrictive effects on industrial production—a question in economic dynamics to which it is not easy to give any decisive general answer. In this connection, attention should be called to the conflict of the claim that "a low level of agricultural prices permits all consumers to spend a smaller part of their incomes for food" (p. 20) with the assertion that "the elasticity of demand when measured in connection with retail prices is larger than unity for practically all agricultural products" (p. 60).

The tracing of effects from large crops and low prices to large exports, a favorable balance of trade, gold imports, increased money in circulation, increased bank reserves and an expansion of credit is clear enough. But most of the correlations between successive pairs of variables in the line of argument are only moderately high. And the effects of the original factor, fluctuations in crop volume, in the final phenomena are not easily appraised.

The resort to a comparison of agricultural factors with business annals when correlation methods yield somewhat inconclusive results is not a procedure to be commended. For such a comparison is so highly subjective and flexible as to involve large but unknown errors. If the author insists on varying lags there is available multiple correlation analysis in which the agricultural factor with various lags can serve as two or more independent variables.

Here and there are to be found statements lacking in precision. On page 7 there is a rather serious exaggeration of the amplitude of the cycles in a two-year moving average of crop production: "deviations of ten per cent from the trend are not rare and in a majority of cases the deviations are larger than five per cent." Actually there is only one deviation out of fifty-five as large as ten per cent and only twelve greater than five per cent. On page 64 occurs a curious non-sequitur. To support the contention that "lags are more regular when development is followed from revival to depression than when it begins with depression," there is cited the fact that stock prices are more closely correlated (using the best lags) with interest rates following than with interest rates preceding. The author's argument would have been equally valid in support of exactly the opposite conclusion!

If there is much to criticize in this study it is at least in part attributable to the difficulty of the problem. For the monograph bears the marks of hard work, technical ability, and a constructive imagination. Scrupulous care in checking theories and facts coupled with a determination to present both sides of the case would have made it an excellent piece of research.

THEODORE O. YNTEMA

The University of Chicago

Federal Financing: A Study of the Methods Employed by the Treasury in Its Borrowing Operations, by Robert A. Love. New York: Columbia University Press. 1931. 256 pp.

It is no small reproach to American economists that an adequate study of our national finances remains to be written. The spade-work of H. C. Adams, Bullock, Dewey, Mitchell, Catterall, a generation ago, held out promise which has not been fulfilled. What remained undone before 1914 must inevitably have waited until our war financing should have "settled"; but a sufficient interval has since elapsed.

Dr. Love's book will not fill the gap; it was probably not designed to do so. The foreword of Professor Seligman is a just account: "The author has discussed with great intelligence some of the less familiar aspects of our fiscal policy." The earlier ground has been retraversed; the dry bones of Liberty Loan financing have been exhumed; examination has been made of administrative and legislative records. But in gathering the leaves, the forest has escaped. To the fiscal student of another generation, the dominant fact of our late financing is that the Treasury prepared for the War, carried it on, and extricated itself from immediate commitments by means of inflation. Of this fact no reader of Dr. Love's book would be made aware.

The lamented Francis A. Walker years ago likened the effect of Thornton's unassuming *Fortnightly* article in evoking Mill's recantation of the wage fund theory, to the bewilderment of a hunter who pops away at an overhead squirrel and has a bear come toppling stone dead at his feet. In something of this spirit at least one reader after trudging through page after page of Dr. Love's chronicle, wincing at restraint become avoidance ("too controversial to summarize here"; p. 218) has rubbed his eyes in delight at the vigor of a final paragraph:

> In not a single major period in American finance has the Treasury manipulated matters so as to avoid the unfortunate confusion and the costly results which follow in the wake of badly used financing tactics. The misuse of both security features and financing devices may accordingly be described as characteristic of American financing. This unfortunate situation cannot be explained in any terms other than those describing ignorance of the principles of finance, lack of knowledge of financing tactics, and unfamiliarity with the operation of adopted measures. The only consolation we get out of this thought is that there is some chance that the future will witness the elimination of the defects of the past.

Admirable in appraisal and commendable in piety.

JACOB H. HOLLANDER

Johns Hopkins University

Government Control of Crude Rubber, by Charles R. Whittlesey. Princeton: Princeton University Press. 1931. 229 pp.

This book, the second of the publications of the International Finance Section of the Department of Economics and Social Institution in Princeton University, on the Walker Foundation, is an exhaustive examination of the British Government's recent attempt to stabilize the price of crude rubber (Stevenson Plan, 1922–1928). The study attempts "to analyze the conditions that led to government control in the industry, to examine the plan itself with all its various modifications, and to assess the effects of restriction upon producing countries, upon the principal consuming country (America) and upon the principal investing country (England)."

With the exception of the theoretical content of the concluding chapters, the study is a factual description of all sides of the restriction question. The author has done a careful and thorough piece of work but the complete absence of any statistical analysis of the plenteous data and the little use made of graphic methods in their presentation are disappointing. No attempt has been made to relate changes in the supply and demand factors, or to contrast the scattered elements of the problem. In the thirty-five tables, however, much statistical detail is presented, for the investigation has scarcely left a phase of the subject untouched. A comprehensive bibliography is also included. As an authoritative reference work, the book is invaluable.

To understand fully the problems confronting the rubber producers it is necessary to appreciate the continuing nature of their industry, with some five or six years, on the average, required for the maturing of the rubber trees. The expansion of rubber production in the Dutch East Indies during restriction (1922–1928) was only made possible by the extensive plantings during and immediately following the World War, while the even greater plantings encouraged by restriction prices have just come into production within the past few years. It is of striking significance that in this greatly increased Dutch production the rôle played by the small-scale, native producers, as contrasted with that of the large plantations, has been increasingly important. Because of lower all-in production costs, these independent native growers may eventually displace their European competitors, and any future attempts at price control will be greatly handicapped as a result.

In view of this long term nature of the industry, reduction of the fluctuations in the price of crude rubber is essential to rationalized production. Stabilization of prices, moreover, is not of itself contrary to the interests of the rubber manufacturers in the United States. Chief among their objections to the Stevenson Plan were the undue amount of uncertainty allowed to arise concerning restriction policies, and the extreme inflexibility of the control mechanism—both questions, not of principle, but of administrative control. Aside, however, from allaying the rising fear among American consumers of a future shortage of crude rubber, the disadvantages of the experiment, to both the producer and the consumer, have far outweighed any possible gains.

The history of the Stevenson Plan has again shown that any stabilization scheme which concerns itself solely with current production and neglects the fundamentally more important question of productive capacity is bound to fail. Temporary gains found in the liquidation of accumulated stocks are more than offset by greatly increased potential supplies. And in view of the present need for a critical evaluation of all attempts at the control of economic processes, investigations such as the one under review are especially welcome.

CHARLES A. BLISS

American Industry and Commerce, by Edward Dana Durand. Boston: Ginn and Company. 1930. xviii, 653 pp.

The attempt to describe and interpret the United States has been for some years the sport of foreign visitors. Their descriptions have usually been impressionistic with obvious attempts to be brilliant in style and startling in concept. It will no longer be necessary for them even to visit the United States to gather material. Dr. Durand has undertaken "to set forth systematically the major facts regarding the present riches of the country, the character and magnitude of its industries and commerce, and the history of its material developments, especially during recent decades." Such an undertaking is a most difficult assignment, even for one with Dr. Durand's ability and background. As a former director of the United States Bureau of the Census and at present statistical assistant to the Secretary of Commerce, his familiarity with available statistics is unquestioned. Both the *Statistical Abstract of the United States* and the invaluable *Commerce Yearbook* series have passed through his hands. The volume represents the most complete summary of American economic life in statistical terms which the reviewer has ever seen, short of a five-foot shelf of the original sources themselves. It is a powerful demonstration of the utility of statistical measures in tracing historical trends and in describing present conditions.

The plan of the book is one of giving a picture of American well-being and then explaining how it has come about. The first chapter presents data on the national income, wages, the volume of production and consumption, leisure and recreation and the like. The demonstration is very clearly one of world leadership. Dr. Durand feels that it is now possible to say that "for the first time in history man has reached a height whence he can dimly see ahead the Promised Land. From the material standpoint, at least, the Utopia of the philosophers and the romancers seems no longer an altogether idle dream." (p. xvi.) The book then proceeds to describe the developments of the 19th and 20th centuries, with separate chapters discussing the primary factors in American progress, population and natural resources, and a further chapter discussing secondary factors, including the spread of education and research, the position and attitude of labor, the use of capital, heat and power, large scale enterprise, mass production, system, and the combination of initiative and collective action. The remainder of the book deals with various divisions of economic activity, industrial and geographical, ending with a discussion of foreign trade. The subject-matter relates primarily to the production and distribution of commodities. The banking system and the security markets, the character of taxation, the extent of trade unionism and many other similar topics do not fall within the scope of the book. Yet one hesitates even to mention omissions, in the face of the extraordinary area which Dr. Durand does succeed in covering with clarity and succinctness.

Dr. Durand's interest is in the long term trend and many of his statistics are in terms of decades or longer intervals. Such matters as the present depression do not concern his study. As he puts it, "from the broad point of view the crises of the past have been mere waves on the stream blowing steadily onward." (p. 208.) The problem of technological unemployment is dismissed by remarking on the new fields in which employment has increased. The farmers are shown to be better off than at the beginning of the century and the present agricultural difficulties are discussed briefly in connection with price movements. The petroleum industry is presented as an example of enterprise, ingenuity and daring. The entire field of marketing is given little consideration because of the absence of reliable information. Advertising is included as part of the "reasoned conduct of business" and the supremacy of the United States in this field is found to be a factor in prosperity and progress. The tariff has no mention in the chapter on foreign trade. Realizing the danger of being classed as an over-zealous apologist for the American economic order, Dr. Durand cautiously disclaims in the introduction any advocacy of every American institution and practise. His position is rather that the "real prosperity and progress of the country and the real well-being of the masses of the people (as judged, of course, by comparison with other peoples and other periods of time) do constitute strong arguments in support of the general soundness of American economic and political institutions and policies." (p. xvii.)

The volume is not merely a statistical summary. Dr. Durand has cleverly reduced the volume of statistics by using graphs wherever possible. Beyond this, however, should be noted his continual running comment on the adequacy of the statistical material and in interpretation of the data. His comments on national income estimates, cost of living estimates and production indexes are shrewd. In the field of interpretation, it should be noted that Dr. Durand is a firm believer in historical continuity. He dismisses the problem of over-capacity by saying that "capital has been piling up and productive capacity expanding, not only in America but pretty much all over the world, through all modern history. Yet prosperity and well-being are much higher than ever before in America." (p. 207.) He dismisses the question of the development of manufactures in economically backward countries reducing the demand for the products of the leading industrial countries, by remarking that a similar development has gone on for decades without reducing the exports of industrial countries. The same logic leads to the anticipation of further prosperity and progress for America. Dr. Durand wisely emphasizes the fact that "the wealth which by good fortune is theirs (Americans') does bring with it the possibility and the duty of exercising a large measure of leadership in the economic life of the world and, if they prove worthy, a large share of leadership in all that constitutes civilization." (p. xvi.)

WILLARD L. THORP

Amherst College

America Weighs Her Gold, by James Harvey Rogers. New Haven: Yale University Press. 1931. 245 pp.

Professor Rogers has performed a useful service by reminding us that gold movements are caused not only by those forces which shifts in the gold supply produce, but also by the many diverse elements that comprise the balance of international payments. He has marshalled the available facts to show how and why the automatic adjustments assumed in international trade theory have failed to operate in the last fifteen years. Now when there is so much discussion of the maldistribution of gold, such an analysis is needed to show the various channels through which any redistribution of the gold supply will have to be effected.

Illustration of the complexity of the problem is provided by the sequence of events that led to the increase in the post-war monetary gold stock of the United States. Credits were first given to belligerent countries to cover sales of war supplies and consumption goods at high prices. Post-war attempts to repay these unproductive credits by nations impoverished by the lack of productive equipment and at lower price levels inevitably led to the shipment of gold. This gold at first failed to exercise an influence upon credit and prices in this country because it was used to reduce the indebtedness of member banks at the reserve banks. This represented the liquidation of the war-time inflation. Foreigners liquidated their debts to us by shipping gold, which relieved us of some of the burden of liquidation, but did so only because currency depreciation had made gold unnecessary.

Analyses of balances of payments since 1922 reveal the large international movements of capital and short-term credits, which balanced this country's excess of exports and receipts from foreign debts and made unnecessary the trade and price adjustments which should theoretically have resulted from gold imports. The expansion of credit in this country on the basis of the new gold led to active bond and stock markets, including for a period a voracious appetite for foreign securities. The growing speculative mania for American stocks not only led to the excessive use of credit for domestic purposes and checked the sale of foreign securities in this market, but in addition attracted funds from abroad for investment in American stocks and for lending on our tightening money markets.

The strain these developments placed upon money and commodity markets, the eventual breakdown, and the subsequent depression are described. Again, as after the War, international exchange of goods and capital broke down under the process of credit liquidation, and it was necessary for foreigners to ship us gold to meet maturing obligations. Again, in the absence of domestic demands for new credit, this gold was partially used to reduce obligations of member banks at the reserve banks.

Professor Rogers uses the balance-of-payments estimates of the Department of Commerce to illustrate the developments of the 1922–1930 period. The limitation of the figures presented, however, to net balances of capital and credit movements, as well as of commodity trade, fails to reveal the relative magnitude of the various offsetting forces, e.g., the heavy investments of foreigners in American securities during 1928 when American investments abroad also reached their maximum. Statistically, the total magnitudes are probably less accurate than the net movements, but for the purpose of appraising the various forces at work the totals are often important.

Considerable emphasis is placed upon the American tariff as a preventive of normal trade adjustments. The vehemence of the author on this point and the emotional quality of some of his argument seem to this reviewer, despite sympathy with the viewpoint expressed, to detract somewhat from the strength of the position taken. A more objective attitude might have been more convincing. The attitude of our government toward war debts is also condemned with some vehemence. In any event it is clear that these official policies were important factors in complicating the task of balancing international payments and in making persistent the tendency for gold to flow to this country.

In approaching suggested solutions, Professor Rogers presents a chapter of literary quotations, ranging from Fabre's description of caterpillars blindly following each other in a circle to André Siegfried's description of the Scopes trial and a political campaign argument for the tariff, designed to show the tendency of animal and man to persist in following established grooves of thought and action although the way to betterment lies within view of those who would see. One gathers from the remaining chapters that in Professor Rogers' opinion the way to betterment lies in three channels: easing of tariffs and trade restrictions, reduction or cancellation of war debts, and raising of prices through the medium of central bank credit policy.

Professor Rogers does not develop the processes by which central bank credit policy may bring about the necessary readjustment. His belief that something can be done is stated as dogma, primarily on the basis of the principle of economic theory that easier money in one country than in others eventually brings about the price readjustments which will effect the balancing of international payments through trade channels. Earlier chapters of the book demonstrate clearly that such price readjustments did not take place in the 1922–1929 period. Can it be assumed that they will in the future? If so, then it needs to be explained what different factors may be operative. In the past decade the adjustment was made through the export of American capital and credits, which provided foreigners with purchasing power to buy our goods. But did they first get our credits and then buy from us or did they purchase our exports and then find it necessary to obtain funds to balance their payments? Quite obviously it is futile to attempt to fix such sequences; both undoubtedly occurred.

It yet remains to be explained why our exports were not curtailed when loss of gold and borrowing by other countries were necessary to pay for them. The types of goods sold, cost differentials, selling methods, etc., must to some extent determine the flow of commodity trade independent of credit factors. There were also influences which kept prices from rising in this country despite the abundance of credit. Will these influences continue to operate? These independent trade and industrial factors assisted in determining the international flow of goods and funds. It would be instructive to know, for example, why exports from this country maintained their relative position in the total of world trade and those of Germany increased, while the position of England in this respect deteriorated. These contrasts must be to a large extent due to those various factors that determine competitive supremacy in trade rather than to the balancing of opposite credit and capital movements. It could hardly be expected that Professor Rogers would attack this complex question in a book of limited scope, but an analysis of trade as well as of credit factors is needed for a full understanding of the so-called gold problem.

Dramatic events of recent weeks, since this book went to the printer, have effected a redistribution of the world's gold supply in a manner and for reasons not suggested by Professor Rogers. The initial phases of the present crisis are discussed but the probability of a tremendous flow of gold from this country because of a breakdown of confidence, a flight from the gold-exchange standard, and a world-wide passion for liquidity was apparently not anticipated. Professor Rogers mentions the influence of the gold-exchange standard and of confidence as a determinant of the flow of gold to this country. Recent events would seem to demonstrate that funds of such a nature are subject to call in an emergency and to indicate that it is incumbent upon centers holding such balances to maintain abundant gold reserves. To the elements of trade, capital movements, and short-term money-rate differentials should be added the element of confidence as a determinant of the flow of international payments.

WOODLIEF THOMAS

An Introduction to Medical Statistics, by Hilda M. Woods and William T. Russell. London: P. S. King and Son. 1931. 125 pp.

In the preface Dr. Major Greenwood declares that the young medical men and women coming under instruction in the Division of Epidemiology and Vital Statistics of the London School of Hygiene and Tropical Medicine are taught to carry out with facility and confidence the statistical operations which a Medical Officer of Health must supervise. The object of this book, according to Dr. Greenwood, is to help these students acquire such facility and confidence.

In the opinion of the reviewer, the authors have failed definitely to accomplish the purpose they had in view. In general, it may be noted that the explanations are vague and often misleading. A few illustrations of inadequacy of treatment may be found as follows: On pages 4 and 5 "de facto" and "de jure" populations are discussed without clear definition; on page 11 the passage on quantitative data is meaningless; on page 22 the statement that the scale of a simple line chart *must* begin at 0, "even if the smallest observation is well above 0," is fallacious; on page 31 "fertility" is discussed when "fecundity" is meant; on page 35 the definition of infant mortality is clearly wrong; on page 40 the definition of an attack rate and the example of an attack rate do not agree; the text of the chapters on averages, measures of dispersion and correlation will certainly mislead students; the chapter on life tables is badly confused; and the sampling chapter seems nowhere to be suited to the needs of students examining quantitative data on pathological phenomena.

The entire book is supposed to be an introduction to medical statistics, and no definition of "medical statistics" is stated. The authors could have given at least a definition of the scope of the book, using perhaps the "assembly" definition of Oesterlen or the "investigation" definition of Prinzing, in the lack of any definition of their own, and presenting a discussion of the subject on the basis of that definition. It seems impossible to impart instruction in a subject without telling the students what the discussion is about.

E. W. KOPF

Metropolitan Life Insurance Company

An Elementary Treatise on Actuarial Mathematics, by H. Freeman, M.A., F.I.A. Cambridge University Press. 1931. 399 pp.

It is unfortunate, in view of the merits of this book, of which it is difficult to speak too highly, that the opening paragraph of this review should be in the nature of a mild criticism. It seems necessary, however, to point out that the subjects treated in the book are not what one might infer from the title, namely, the mathematics of the application of the theories of probability and of compound interest to insurance. The design of the book is to gather together into a single volume the elementary parts of those branches of general mathematics of which only the general principles are necessary for the actuarial student and thus to relieve him from the necessity of searching out in a larger treatise those parts that he needs. With this in mind we are not surprised that algebra is not one of the subjects treated. The knowledge of that subject required is so extensive that separate textbooks should be used.

The first chapter is devoted to trigonometry, covering the definition of the trigonometrical functions, the measurement of angles and the functions of the sum or difference of two angles.

The next seven chapters cover more extensively the subject of finite differences including interpolation and summation. These 112 pages with their numerous examples, if thoroughly mastered, should give a good working knowledge of the subject. Osculatory interpolation is not mentioned here but is briefly discussed later under differential calculus.

The ninth chapter takes up the question of functions and limits. The treatment is necessarily brief, and it was apparently intended as a review preparatory to the study of the differential calculus to which the next four chapters are devoted. These cover, in addition to the elementary explanations and standard forms, such subjects as expansions, maxima and minima, indeterminate forms and partial differentiation.

Four chapters are then given to the integral calculus, including integration by parts and definite integrals and a very valuable chapter on approximate integration. The last two chapters of the book cover briefly the subject of probability, one chapter taking up questions not involving the calculus and the other those involving it.

While there are a few paragraphs in the book that one might have liked better if written differently and a few typographical errors, they are not such as to detract seriously from the very great value of the work. It should be useful not only to actuarial students but also to statisticians, engineers and others requiring a practical working knowledge of the subjects covered.

ROBERT HENDERSON

Business Forecasting, by Lewis H. Haney. Boston: Ginn and Company. 1931. xiv, 378 pp.

This volume presents a condensed and non-technical summary of a wide field of established knowledge and relevant experience offered "to help lay a basis for scientific business forecasting" (p. vi). Instead of devoting itself to an excogitation of objective grounds for some single system of telling the turns, as so many books on the subject do, the discussion ranges over a wide area, and is made interesting by bits of wisdom gleaned from the author's practical experience as the director of the Bureau of Business Research of New York University.

The first half of the book is a brief survey of the disciplines which provide the technique and intellectual background of forecasting. Statistical technique is discussed in Chapter II, while the statistical data available for various economic processes are listed and critically evaluated in Chapters III, IV and V. The intellectual background provided by economic theory is introduced briefly in the first chapter, and is discussed at greater detail in Chapters VI and VII which deal with the various explanations of the business cycle and *a* theory of the business cycle as conceived by the author.

The second half deals with problems of forecasting proper. The discussion stresses the procedure associated with the author's name, viz. the use of the P/V line which relates the rate of change in the volume of production to that in prices (Chap. VIII). There follow two interesting chapters on forecasting general business trends (IX and X) and a valuable discussion of forecasting for particular industries (Chap. XI). The last three Chapters (XIII–XV) are devoted to an elementary exposition of stock market forecasting, following upon rather scanty notes on commodity prices, interest rates, building activity, automobile production and retail trade (Chap. XII).

The discussion is a mixture of elementary statistics, elementary economics, considerable common sense and empirical wisdom, and not a little of pure forecasting mythology. The various parts of the book are more or less valuable as one or the other of these constituent elements preponderate in the author's treatment of the subject.

The chapters on statistical technique and the use of statistical analysis are disappointing. It is not that they are too elementary—for such was probably the expressed purpose of the author. It is that the treatment perpetuates the besetting sin of the current analysis of time series—the use of frequency-distribution measures without the realization of their limited value in application to time sequences. The usual trinity of least squares, correlation and straight line trends is discussed without any definite indication of their limitations. None of the logically more suitable methods is even mentioned. There is altogether a surprising failure to refer to the existing literature and to help the willing reader extend his knowledge of the technique of statistical experiments.

The use of data for inferential purpose is not always above reproach. The author tends to draw inferences from charts, which, on their face, might lead other observers to arrive at different conclusions, and which, because of the short period of time covered, cannot yield significant results. Thus, to cite an example, on Figure 38 (p. 253) the *S*-like line fitted to the scatter of cotton supply and prices is an obvious misfit in the second half of the diagram. Few of the charts go back of 1919, and some stop short of 1920 and 1921. The essential basis of forecasting, the establishment of repeatable statistical sequences buttressed by significant economic relationships, is frequently absent in some of the series regarded as good "forecasters."

The discussion of the concept and theories of business cycles is brief and sketchy, as are some of the author's critical comments. It is true that this is counterbalanced by a more penetrating discussion in Chapter VII which presents Dr. Haney's own viewpoint on the cycle, a theory which embraces most of the significant factors mentioned by various hypotheses. But even here there are some unwarranted generalizations, such as the precedence of the turn in prices to that in volume of production at the peak of the typical cycle.

The discussion improves in interest and increases in value as it passes to forecasting proper. Here accumulated experience lends weight to the statements made. While some emphasis is placed upon the P/V line approach, the author's catholicity permits discussion of a number of other elements and urges upon the reader a wholesome distrust of any one system of prognostication. Chapter VIII presents an unnecessarily difficult exposition of the simple ideas underlying the relation of changes in production to changes in prices. But the chapters following are stimulating. The table of "Don't for Forecasters" (p. 230) is worthy of framing. And the chapters on stock market forecasting are clear and interesting.

The contrast between the first and the second half of the book emphasizes the virtues and faults of present day forecasting. Judged by Dr. Haney's discussion, business forecasting lacks a general theory of the nature of relationships underlying prognosis, as well as the technique of properly revealing these relationships. The absorption in practical questions, the necessity of paying attention to the transient and passing elements of the day-to-day situation prevent the practitioners from attempting to formulate clearly the general logical grounds of their procedure or to exploit to the full statistical and other tools whose value should be apparent. But when it comes to practical questions, forecasters are likely to produce valuable tentative generalizations. And if they happen to be, as is Dr. Haney, temperamentally circumspect and attentive to all the elements in the situation, the description of forecasting theory in specific markets is likely to be instructive.

But without the distinct theoretical background even the best may become prey to mythology. Let the reader consider carefully the following sequence of statements: "It is common to find minor peaks, or 'shoulders,' in the curve of industrial activity, both in the expansion and in the contraction phases of the cycle. . . . The author would advance the hypotheses that *these shoulders are apt to occur at about the time that production first swings past the line of normal trend,* whether on the upward trend or during recession. The preliminary reaction on the rise may be a sort of premonitory response to growing overproduction. The rally which so frequently interrupts a major recession may be a rebound after falling below normal, the first rush of curtailment having been perhaps too rapid.

"This thought suggests the further hypothesis that *these shoulders are significant in locating the line of normal trend* and in indicating any changes therein" (pp. 162–163).

SIMON KUZNETS

National Bureau of Economic Research

Seasonal Variations in Employment in Manufacturing Industries: A Statistical Study Based on Census Data, by J. Parker Bursk. Philadelphia: University of Pennsylvania Press. 1931. 197 pp.

Konjunktur- und Saisonempfindlichkeit in der Fertigwarenwirtschaft, bearbeitet vom Institut fuer Wirtschaftsbeobachtung. Nuernberg: Verlag der Hochschulbuchhandlung Krische & Co. 1931. 48 pp.

Mr. Bursk's study, carried out under the auspices of the Industrial Research Department of the Wharton School of Finance and Commerce, is based on the employment data contained in the reports of the United States Census of Manufactures. It covers the census years during the period 1904–1925. The year 1927 was not included because the needed data, though reported, were never tabulated. "The seasonal indices were obtained by taking a selected arithmetic mean of the relatives for each month, omitting the largest and the smallest values in an endeavor to eliminate the extreme cyclical and random effects which were evident in certain years. . . . The values so obtained were centered on the average for the year taken as a hundred." These seasonal indices are presented in tabular as well as graphic form, each diagram containing a graph showing the "dispersion" of the index.

In order not to obscure the range of the actual fluctuations, the author has refrained from giving composite indices covering all of the industries analyzed. Instead, indices are presented for the separate industries or groups of industries, and, to clarify the summary picture, the seasonal ranges of the individual manufacturing industries are summed and classified into "consumer's goods" and "producer's goods." The "consumer's goods" are again divided into those subject to "elastic" and to "inelastic" demand, while the "producer's goods" are broken up into "raw materials" and "intermediate goods." A "percentage seasonal range" is given as the measure of the seasonality of every such group and the industries constituting the group.

The table below summarizes the findings as to seasonal variations and shows also the absolute effect on the wage earners involved, when the seasonal range is applied to the number of wage earners reported in the 1927 census.

	Average number employed in 1927	*Average per cent seasonal range*	*Absolute range, number wage earners*
Producer's goods	2,890,576	9.8	283,104
Raw materials	680,823	6.5	44,205
Intermediate goods	2,209,753	10.8	238,899
Consumer's goods	2,800,090	18.4	514,686
Elastic demand	2,152,337	21.8	469,359
Inelastic demand	647,753	7.0	45,327
Total, all manufacturing industries	5,690,666	14.0	797,790

An attempt to discover a relationship between the magnitude of the seasonal ranges and the percentages of female workers employed in an industry, or the seasonal ranges and the size of the establishments concerned, resulted in no significant correlation ratio.

The findings of the Wharton School study indicate that, so far as manufacturing industries are concerned, the range of the seasonal fluctuations increases as the product becomes a consumer's good (except in the case of inelastic consumer's goods). The German study comes to the same conclusion. The Institut, confining itself to German manufacturing industries, sought to determine the comparative sensitivity of various branches of the manufacturing industries to cyclical and seasonal factors. It discovered that the cyclical influence becomes weaker as the consumer is approached, while the seasonal influence *grows* in the consumer's direction.

Neither of the studies reviewed enters into a discussion of the economic or social consequences of the phenomena which they verify statistically. For that matter, these economic phenomena were known and discussed in books and articles by W. C. Mitchell and S. S. Kuznets, both of the National Bureau of Economic Research, and have been an economic commonplace for quite some time.

Yet, both studies *measure* the factors with which they deal and, therefore, afford not only greater insight into the workings of a competitive economic system, but quantitative knowledge sorely needed in the formulation of the theory and administration of unemployment insurance.

DAVID WEINTRAUB

National Bureau of Economic Research

Mexican Labor in the United States—Bethlehem, Pennsylvania, by Paul S. Taylor, University of California Publications in Economics, Vol. 7, No. 1. Berkeley: University of California Press. 1931. ix, 24 pp.

A delightful miniature but graphic sketch, based on extensive interviewing, of the "farthest northeast" colony of Mexicans, a few hundred strong, at Bethlehem, chiefly in the steel industry. Initiated by trainload importations from Texas in 1923, to meet a labor shortage, the colony has gradually achieved relative stability at somewhat less than half of its numbers at the peak. Members of the group participate but little in political activities and cherish the idea of a return to Mexico. They appear to suffer no marked social or economic discriminations; though, due partly to language difficulties, most of them are employed as common laborers.

HARRY JEROME

University of Wisconsin

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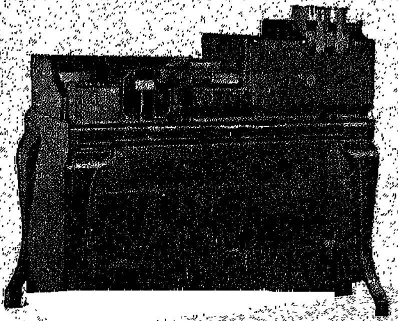

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FURTHER EXPERIMENTS ON THE SAMPLING DISTRIBUTION OF THE CORRELATION COEFFICIENT

By Leone Chesire and Elena Oldis, *University of Iowa*,
and Egon S. Pearson, *University of London*

1. The theoretical law for the sampling distribution of the product-moment coefficient of correlation, r, has been established only in the case where the two variables are normally correlated in the population sampled.[1] Little is known about the nature of this distribution in other cases, though a certain amount of experimental investigation has been carried out, which suggests that the distribution is not very sensitive to changes in population form.[2] It is clear that each additional piece of experimental evidence will contribute its part toward a final picture of the situation, and therefore it has seemed of value to record and analyze briefly the following series of sampling results.

2. The two forms of population or universe from which samples were drawn, have been based upon urn schemata devised by Professor H. L. Rietz.

Case I. Suppose that two ordinary six-faced dice are thrown onto a table, giving scores of d_1 and d_2, and that we write $d_1+d_2=x$. One die chosen at random is then picked up from the table (suppose it had the score d_1) and thrown again giving a score d_3. Then $y=d_2+d_3$, and x and y are two correlated variables. The expectations of different combinations of x and y in 216 throws are shown in Table I, and these relative frequencies have been assigned to an infinite universe from which random samples were drawn.

---

[1] R. A. Fisher, *Biometrika* X, p. 511.

[2] The original sampling experiments of this nature were undertaken by Student, *Biometrika* VI, pp. 302–310, before Fisher's distribution was known. The population which he sampled was, however, approximately normal. Some later work is as follows:

(a) For the case where the population coefficient ρ is zero: G. A. Baker, this Journal, December 1930, pp. 387–396; E. S. Pearson, this Journal, June 1931, pp. 128–134.

(b) For the case where ρ is not zero: E. S. Pearson, *Biometrika* XXI, pp. 356–360.

TABLE I

URN SCHEMA FOR UNIVERSE I

$y \backslash x$	2	3	4	5	6	7	8	9	10	11	12	Totals
12	..	..	..	..	..	1	1	1	1	1	1	6
11	..	..	..	..	1	2	2	2	2	2	1	12
10	..	..	..	1	2	3	3	3	3	2	1	18
9	..	..	1	2	3	4	4	4	3	2	1	24
8	..	1	2	3	4	5	5	4	3	2	1	30
7	1	2	3	4	5	6	5	4	3	2	1	36
6	1	2	3	4	5	5	4	3	2	1	..	30
5	1	2	3	4	4	4	3	2	1	.		24
4	1	2	3	3	3	3	2	1	..			18
3	1	2	2	2	2	2	1	..	..	..		12
2	1	1	1	1	1	1	..	..	..	..		6
Totals..	6	12	18	24	30	36	30	24	18	12	6	216

It will be found that: (a) the marginal distributions of x and y are the same and may be termed "triangular"; (b) the regression is linear and the correlation coefficient, $\rho = \frac{1}{2}$; (c) the arrays are not homoscedastic.

Case II. In the second scheme, it is supposed that $d_1 \leq d_2$, and it is the die with the lower (or equal) score which is always to be removed from the table and thrown again; it then gives d_3. Again $x = d_1 + d_2$, $y = d_2 + d_3$, and the expectations among 216 throws are shown in Table II. In this case, (a) the distribution of x is as before, but that of y has become asymmetrical; (b) the regression is no longer linear, and $\rho = .5462$; (c) the distributions in the arrays are again very varied in form.

TABLE II

URN SCHEMA FOR UNIVERSE II

$y \backslash x$	2	3	4	5	6	7	8	9	10	11	12	Totals
12	..	..	..	..	..	2	2	2	2	2	1	11
11	..	..	..	..	2	4	4	4	3	2	1	20
10	..	..	..	2	4	6	5	4	3	2	1	27
9	..	..	2	4	5	6	5	4	3	2	1	32
8	..	2	3	4	5	6	5	4	3	2	1	35
7	1	2	3	4	5	6	5	4	3	2	1	36
6	1	2	3	4	5	4	3	2	1	..	.	25
5	1	2	3	4	3	2	1	..	..	..	..	16
4	1	2	3	2	1	..	..	..	..	..	..	9
3	1	2	1	..	..	..	..	..	..	..	..	4
2	1	..	..	..	..	..	..	..	..	..	..	1
Totals..	6	12	18	24	30	36	30	24	18	12	6	216

It is true that in a case of non-linear regression the coefficient of correlation is no longer a very adequate measure of association, but a study of its variation from sample to sample is still a matter of interest, particularly for the light which it throws on the sensitivity of the distribution of r to changes in population.

In both cases 1,000 random samples of 5 were drawn and the values of r calculated. These 1,000 samples were then combined in pairs to form 500 samples of 10, and again into 250 samples of 20. The 10's and 20's do not, therefore, form a completely independent series; for example if there were through chance an exceptional number of low values of r among the samples of 5, we should expect that this result would be repeated to some extent among the samples of 10 and 20. The method of random sampling adopted was as follows:

Each of the 216 pairs of values whose frequencies are exhibited in Table I or in Table II were written on a 2 x 3 inch card. This gave two packs of 216 cards each. With considerable realization of the difficulty of securing a random sample in drawing the sets of 5 cards, the 216 cards in a pack were shuffled thoroughly before taking each sample. The further procedure consisted in drawing out a first, second, third, fourth and fifth card at roughly ½, 1/6, 2/6, 4/6, and 5/6 respectively of the thickness of the pack from its top. The five cards drawn were then returned to the center of the pack. While the failure to replace each separate card before drawing another in a sample of 5 involves a departure from the ideal, it seems that 5 is so small in comparison to 216 that the error introduced by this procedure would be practically negligible.

The samples of 5 were arranged in the order in which they were

TABLE III

DISTRIBUTION OF r IN SAMPLES OF 5

r (central values)	Case I, $\rho=.5000$				Case II, $\rho=.5462$	
	Observed	Normal theory	Approximation 1	Approximation 2	Observed	Normal theory
−.95	4	2.6	1.6	0.7	1	2.1
−.85	2	5.4	6.2	3.5	6	4.4
−.75	4	7.7	10.4	7.1	4	6.3
−.65	6	10.1	14.3	10.8	4	8.3
−.55	16	12.7	17.8	14.6	13	10.5
−.45	12	15.6	21.3	18.4	12	13.0
−.35	15	19.0	24.8	22.5	17	16.0
−.25	19	22.9	28.4	26.8	17	19.4
−.15	24	27.4	32.3	31.4	16	23.5
−.05	35	32.8	36.5	36.5	25	28.5
+.05	42	39.2	41.3	42.2	34	34.5
+.15	52	46.7	46.7	48.8	48	41.8
+.25	48	55.7	53.0	56.3	67	50.7
+.35	85	66.3	60.6	65.1	68	61.7
+.45	101	78.8	69.7	75.5	84	75.1
+.55	98	93.2	81.0	88.1	93	91.6
+.65	113	109.0	95.3	103.2	114	111.2
+.75	122	124.2	113.3	120.4	124	132.5
+.85	117	131.8	133.7	134.7	154	148.9
+.95	85	98.9	111.8	93.4	99	120.0
Totals	1000	1000.0	1000.0	1000.0	1000	1000.0

drawn and the samples of 10 made by combining two consecutive samples beginning with the first sample of 5. This procedure gave samples of 10 formed by one replacement of the cards drawn and thorough shuffling after 5 cards were drawn.

The samples of 20 were made by combining two consecutive samples of 10 arranged in the order in which they were compiled. This procedure gave samples of 20 formed by replacement of the cards after 5 drawings together with a thorough shuffling of the cards.

3. The observed and theoretical distributions of r are shown in Tables III, IV and V. The frequencies in the columns headed "Normal theory" are the expected values on the assumption that the two variables are normally correlated in the universe with ρ equal to .5000 and .5462 respectively. They have been obtained from the tables published in *Biometrika*,[1] which were based on the frequency relation established by R. A. Fisher in the paper referred to above. The

TABLE IV

DISTRIBUTION OF r IN SAMPLES OF 10

r (central values)	Case I, $\rho = .5000$			Case II, $\rho = .5462$	
	Observed	Normal theory	Approximation 1	Observed	Normal theory
Less than −.35	..	3.6	3.1	2	2.3
−.325	1	1.5	1.6	..	1.0
−.275	1	2.0	2.2	1	1.3
−.225	1	2.6	2.9	..	1.8
−.175	1	3.4	3.7	3	2.4
−.125	8	4.3	4.8	2	3.0
−.075	..	5.4	6.0	1	3.9
−.025	2	6.8	7.4	1	5.0
+.025	13	8.4	9.1	9	6.3
+.075	9	10.2	11.0	5	7.8
+.125	15	12.4	13.2	10	9.7
+.175	13	14.9	15.5	13	12.0
+.225	16	17.7	18.2	22	14.6
+.275	21	20.9	21.1	25	17.5
+.325	28	24.3	24.1	18	21.0
+.375	36	27.9	27.3	23	24.8
+.425	38	31.5	30.6	22	28.9
+.475	39	34.9	33.6	37	33.1
+.525	37	38.0	36.4	39	37.4
+.575	50	40.2	38.6	42	41.1
+.625	42	41.1	39.7	51	42.9
+.675	30	40.1	39.3	43	44.9
+.725	40	36.8	36.9	45	43.3
+.775	20	30.5	31.8	31	38.0
+.825	18	22.4	23.8	29	29.5
+.875	14	12.9	13.6	20	17.9
+.925	6	4.6	4.3	6	6.7
+.975	1	0.7	0.2	..	0.9
Totals	500	500.0	500.0	500	500.0

---

[1] "A Co-operative Study," *Biometrika* XI, pp. 379–404.

TABLE V

DISTRIBUTION OF r IN SAMPLES OF 20

r (central values)	Case I, $\rho=.5000$			Case II, $\rho=.5462$	
	Observed	Normal theory	Approximation 1	Observed	Normal theory
Less than $-.10$	..	0.8	0.8	..	0.4
$-.075$	1	0.7	0.7	..	0.3
$-.025$	1	1.1	1.1	..	0.6
$+.025$	1	1.7	1.8	..	0.9
$+.075$	2	2.7	2.8	1	1.6
$+.125$	3	4.0	4.1	2	2.5
$+.175$	1	5.8	6.0	2	3.7
$+.225$	11	8.2	8.4	5	5.5
$+.275$	17	11.2	11.4	3	7.9
$+.325$	19	14.8	15.0	15	11.1
$+.375$	15	18.8	18.8	14	14.8
$+.425$	21	22.9	22.7	24	19.3
$+.475$	31	26.4	26.0	24	23.9
$+.525$	33	28.7	28.2	29	28.0
$+.575$	24	28.8	28.5	26	30.8
$+.625$	24	26.3	26.2	37	31.0
$+.675$	24	21.2	21.4	30	27.7
$+.725$	12	14.5	14.8	23	21.0
$+.775$	5	7.8	7.9	10	12.7
$+.825$	3	2.9	2.9	4	5.2
$+.875$	1	0.6	0.5	1	1.0
$+.925$	1	0.1	....	..	0.1
$+.975$	..	....	....	..	....
Totals	250	250.0	250.0	250	250.0

Biometrika tables give *ordinates* of the curve only; the quadrature formula

$$\int_0^1 y_\theta d\theta = h\left\{\frac{1}{2}(y_0+y_1)-\frac{1}{24}(\delta^2{}_{y_0}+\delta^2{}_{y_1})+\ \ldots\ \right\} \tag{1}$$

was therefore used to obtain the frequencies in groups of width h. Further, for the case $\rho=.5462$ it was necessary to interpolate between group frequencies found for $\rho=.4$, $.5$, $.6$ and $.7$. It is considered that this process should not have led to errors above the order of a unit in the first decimal place.[1] In any case the accuracy is more than sufficient for the purpose required. The frequencies in the columns headed "Approximation 1" and "Approximation 2" will be explained below.

Table VI gives for comparison the observed means and standard deviations and those of normal theory, the latter being again taken from the *Biometrika* tables. The results of testing the goodness of fit

---

[1] Except in the case of the groups in the neighborhood of $r=+1.0$ for the samples of 5, where owing to the abruptness of the curve more ordinates are probably needed to obtain the frequencies to this degree of accuracy.

TABLE VI

Size of sample		5		10		20	
Case		I	II	I	II	I	II
Mean r	Observed	.4542	.4924	.4871	.5289	.4806	.5460
	Normal theory	.4517	.4958	.4787	.5242	.4900	.5359
σ_r	Observed	.3901	.3924	.2371	.2383	.1701	.1503
	Normal theory	.4239	.4076	.2671	.2534	.1780	.1677
Goodness of fit	n^1	19	19	24	23	18	15
	$P(\chi^2)$	.122	.374	.098	.492	.406	.633

between the two series are also shown. The following points are suggested by a study of these tables:

(a) The observed and theoretical values for mean r are in quite close agreement, but the observed σ_r is always less, and sometimes considerably less, than the theoretical.

(b) For $n=5$ in both series of samples there are far too few observed values of r near $r=+1.0$. In all cases there are rather too few extremely low values of r among the observations, this can be seen clearly both for $n=10$ and 20. It is this effect, of course, which is reflected in the low value of the standard deviations.

(c) The frequencies for the samples from the non-linear universe, II, correspond more closely to normal theory than those from the linear universe, I.

(d) The agreement between observation and normal theory increases as the size of sample increases.

(e) The expected and observed frequencies for the case $n=20$ lying beyond values of r corresponding approximately to the 5 per cent and 1 per cent limits are shown in Table VII.

In conclusion it is evident that there are real differences between the

TABLE VII

OBSERVED AND EXPECTED TAIL FREQUENCIES IN 250 SAMPLES OF 20

Case I, $\rho=.5000$				Case II, $\rho=.5462$			
r	Observed	Normal theory	Approximation I	r	Observed	Normal theory	Approximation I
Less than .00....	2	2.6	2.6	Less than +.05..	0	2.2	2.2
Less than +.15....	8	11.0	11.3	Less than +.25..	10	15.5	15.0
Greater than +.75....	10	11.4	11.3	Greater than +.75..	15	10.0	10.3
Greater than +.80....	5	3.6	3.4	Greater than +.85..	1	1.1	1.2

distribution of r in samples from these two populations and those appropriate for the normal case. Whether or no the differences are of an order which would be considered serious in practice, depends upon the degree of accuracy required. But it is clear that the approximation obtained from the normal theory law is far closer than that which would follow from the crude assumption that r was distributed in a normal curve with mean at ρ and $\sigma_r = (1-\rho^2)/\sqrt{12}$. It is not suggested that much weight could be placed in any case on a correlation coefficient obtained from 5 or 10 pairs of values, but the small sample region is always likely to be the one showing greatest divergence from normal theory, and therefore the most important one to examine first. We should anticipate that as n is increased, the differences will decrease.

These experiments of course give no indication of the situation in the case of sampling from non-normal populations with really high values of ρ, say .8 or .9.

4. In an earlier paper,[1] one of the writers has investigated the closeness of agreement between the frequencies obtained from the true sampling distribution of r, and those found from using R. A. Fisher's z transformation.[2] If adequate, the relative simplicity of this method of procedure is obvious and it therefore seems desirable to make here another trial of its degree of approximation.

If we write

$$\left.\begin{aligned} z &= \frac{1}{2}\left\{\log_e(1+r) - \log_e(1-r)\right\} \\ \zeta &= \frac{1}{2}\left\{\log_e(1+\rho) - \log_e(1-\rho)\right\} \end{aligned}\right\} \tag{2}$$

then z is approximately normally distributed with mean and variance as follows

$$\text{Mean } z = \zeta + \frac{\rho}{2(n-1)}\left\{1 + \frac{1+\rho^2}{8(n-1)} + \ . \ . \ . \right\} \tag{3}$$

$$\sigma^2_z = \frac{1}{n-1}\left\{1 + \frac{4-\rho^2}{2(n-1)} + \frac{176-21\rho^2-21\rho^4}{48(n-1)^2} + \ . \ . \ . \right\}. \tag{4}$$

These values have been used in obtaining the figures in the column headed "Approximation 2" in Table III. An approximation of lower order is obtained by using

$$\text{Mean } z = \zeta + \frac{1}{2}\rho/(n-1) \tag{5}$$

$$\sigma^2_z = 1/(n-3). \tag{6}$$

---

[1] E. S. Pearson, "Some Notes on Sampling Tests with Two Variables," *Biometrika* XXI, p. 357.

[2] R. A. Fisher has discussed this transformation in *Metron* I, 4, pp. 12–14.

These values have led to the Approximation 1 of Tables III, IV, V and VII. To obtain the appropriate frequencies it is necessary to calculate ζ from (2) and also the values of z corresponding to the boundaries between the groups of the r distribution;[1] then to enter any tables of the normal probability integral with the ratio, $x = (z - \text{Mean } z)/\sigma_z$.

For the case $n=5$, Approximation 1 is not very satisfactory; this is hardly surprising seeing that the relations (3) and (4) are expansions in inverse powers of $(n-1)$. The use of Approximation 2 leads to considerable improvement. When $n=20$, the agreement between Approximation 1 and the values obtained with much greater labor from the *Biometrika* tables is really very good.

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[1] Fisher has given a table of z, *loc. cit.*, pp. 26–27.

WORLD PRICES AND THE PRECIOUS METALS

By L. C. Wilcoxen

A study of world prices and the precious metals logically begins with the world's production of the latter, and their portions which are used in the arts and money. After this may be found the effects of their cumulative money stocks upon the price levels of the world. Pertinent to these are the statistics of the productions of gold and silver which are readily available as far back as the year 1600. The estimated world's stocks at different dates, as given by Jacob, Tooke and Newmarch are shown on Chart I.

The first obvious relation is that between the productions of these metals and the total stocks. The simplest assumption to be made is that the stocks at any date are equal to those of some prior date plus the period production and corrected by a factor which represents the proportion retained after loss due to wear and tear.

This method of computing total stocks of both gold and silver was undertaken beginning with the estimated total stocks in the year 1600. By the laborious method of cut and try, it was found that the retention factors for twenty-year periods were 93.8 per cent for gold and 96.5 per cent for silver. Since the retention influence is a compound one, the retention percentages for the one-, five-, and ten-year periods are found to be 99.7, 98.4, and 96.9 per cent for gold and 99.8, 99.1, and 98.2 per cent for silver.

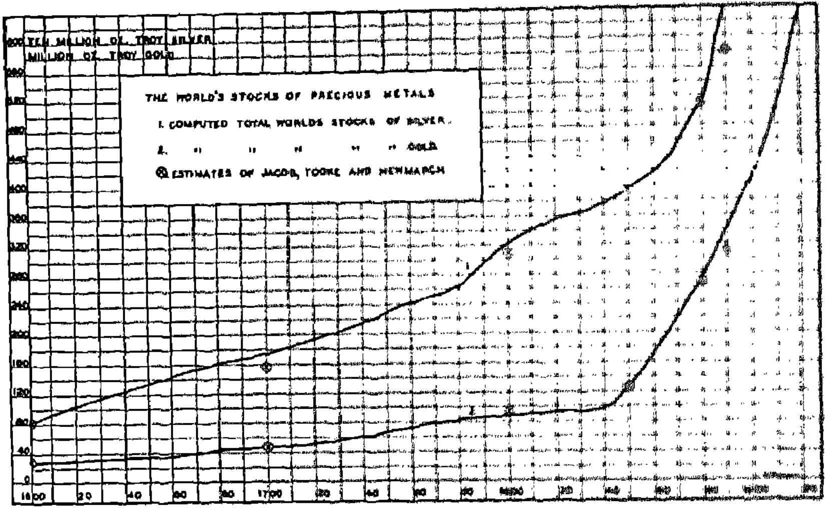
By this method of successively adding productions to prior stocks and correcting for the percentage retained the stocks of gold and silver have been computed. Chart I shows the same compared with the original estimates of Jacob, Tooke and Newmarch. While both the estimates of production and stocks are probably subject to considerable error, the agreement indicates that the assumption was not unreasonable.

Turning to the stock of gold and silver in the arts, it has been found that under a world system of free coinage, these, too, seem to accumulate according to a simple rule. On Chart II compound interest curves have been fitted by the method of least squares to the estimates of Jacob, Tooke and Newmarch for both gold and silver. These curves are represented by the equations:

$$\text{Gold Art Stocks} = 19.02\ (1.0059)^x$$
$$\text{Silver Art Stocks} = 482.3\ (1.0060)^x$$

the origin of x (time) being at 1600.

CHART I



The fit of these curves, it will be noted, is reasonably good.

Next in order come the stocks of money gold and money silver. Chart III shows that these are merely the differences between the computed total and computed arts stocks. Comparison of these is made with the estimates of Jacob, Tooke and Newmarch. Here again, the two are in reasonable accord. It must be borne in mind, however, that with the cessation of the free silver coinage which became important in the 1870's, the above method of computing silver money

CHART II

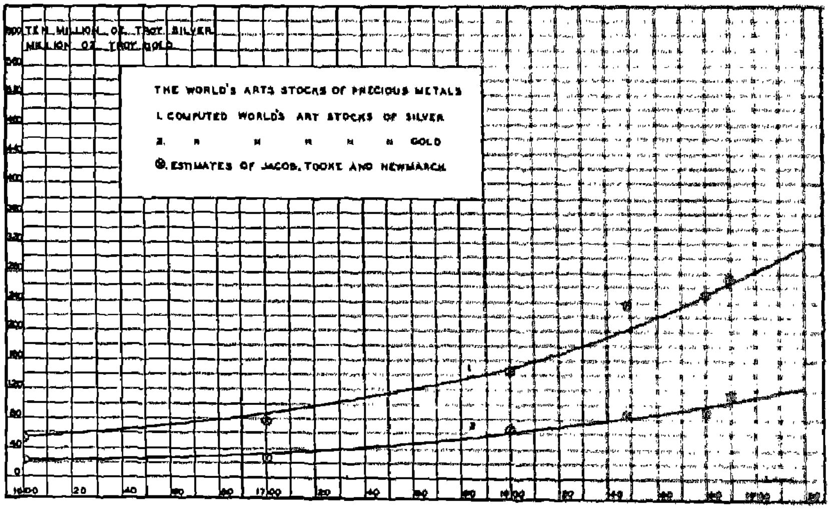
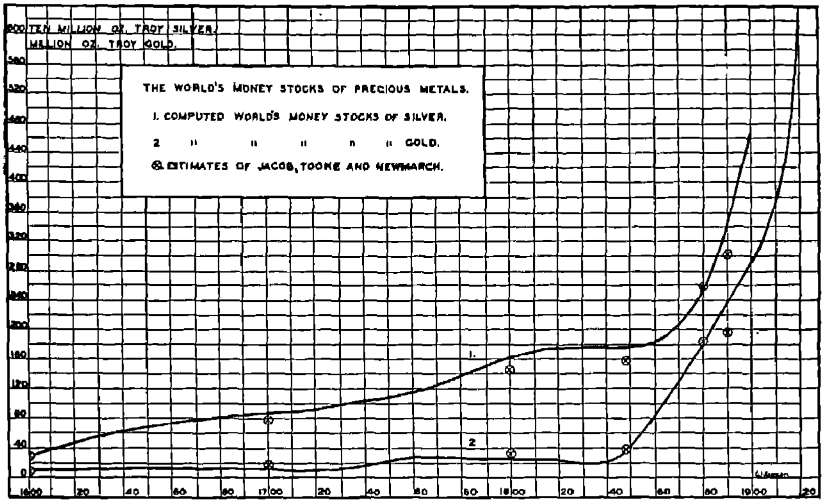


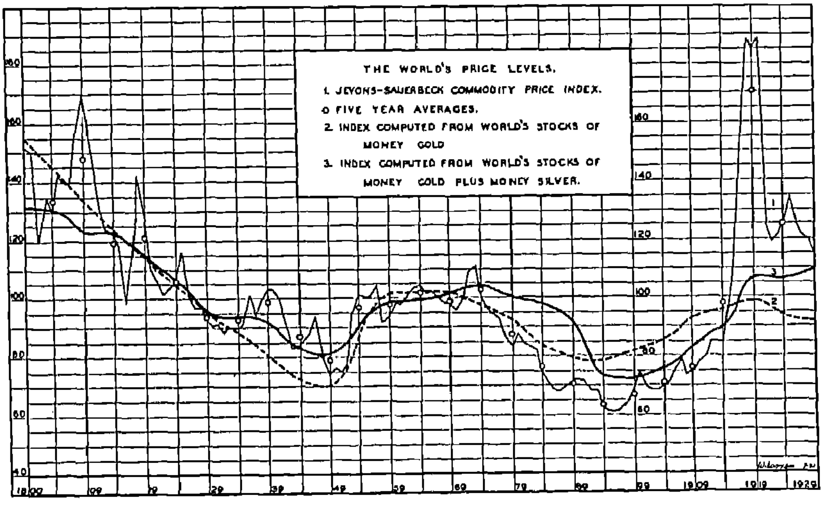
CHART III



stocks begins to fail. No longer could the silver not required by the previous "normal" arts demand be dumped into the money coffers.

It has been asserted by various economists, and recently with considerable vigor, that the rate of money gold accumulation determines the trend of world prices. During those periods that the world's stocks of money gold accumulate faster than approximately 3 per cent per year, prices are supposed to rise, and when it accumulates more slowly than approximately 3 per cent per year prices are supposed to fall.

CHART IV



The primary object of this study is to test the validity of this contention.

If the theory is true, then the curve of gold money stocks divided by a compound interest curve of approximately 3 per cent per year can be made roughly to fit the curve of world prices.

For the world price curve there is available the Jevons-Sauerbeck Index of English commodity prices now being carried forward as the Statist Index. This index is adjusted to the gold basis. This curve is the one generally used to illustrate the history of world prices. It is true that prices in other countries will vary from this but not sufficiently to discredit its use in this study. The index of prices, and their five-year averages, beginning with the year 1800 are shown on Chart IV (Table I).

TABLE I
JEVONS ADJUSTED AND SAUERBECK INDEXES OF ENGLISH COMMODITY PRICES, 1800–1920

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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18[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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18[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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18[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* Jevons adjusted indexes. Source: *Journal of the Royal Statistical Society*, 1865. Factored by 1.08 to reduce to Sauerbeck base.

† Adjusted to gold base by multiplying by average dollar exchange rate for year divided by 4.86

The general equation of the curve which we are to fit to this price curve is:

$$P = \frac{G}{A(1+i)^x}$$

in which P = Computed price index,

G = Stocks of Money Gold,

i = Required annual rate of money gold accumulation to maintain price level unchanged,

A = An arbitrary constant,

x = The number of elapsed years from the origin (year 1800).

Before proceeding it is necessary to obtain statistics of the amount of money gold existing at frequent intervals. Kitchin has recently published his estimates beginning with the year 1839 and at five-year intervals. While these figures are probably subject to considerable error they are accepted as the best available data. For the year 1800 the estimate of Jacob, Tooke and Newmarch is accepted. The money gold stocks for the intervening period from 1800 to 1839 are interpolated on the assumption of a straight line change between these two dates. These data, all of which are reduced to Troy ounces, are found in Table II, column 1.

The curve $P = \dfrac{G}{A(1+i)^x}$ may be transformed to

$$\frac{G}{P} = A(1+i)^x \text{ and then to the form:}$$

$$\log \frac{G}{P} = \log A + x\,[\log\,(1+i)].$$

TABLE II

COMPUTED PRICE INDEX BASED UPON THE WORLD'S STOCKS OF MONEY GOLD, QUINQUENNIALLY, 1800–1929

Date	(1) G (million oz.)	(2) 1.02645^x	(3) Column (2) times .2063	(4) P
1800	31.92	1.0000	.20630	154.6
1804	33.38	1.1110	.22920	145.3
1809	35.20	1.2648	.26093	134.6
1814	37.02	1.4411	.29730	124.6
1819	38.85	1.6420	.33875	114.7
1824	40.67	1.8710	.38599	105.2
1829	42.49	2.1318	.43979	96.6
1834	44.32	2.4290	.50110	88.5
1839	46.14	2.7678	.56270	82.0
1844	47.31	3.1534	.65055	72.7
1849	51.55	3.5931	.74126	69.5
1854	74.38	4.0940	.84459	88.1
1859	98.16	4.6647	.96233	102.0
1864	112.05	5.3150	1.09648	102.2
1869	127.82	6.0560	1.24935	102.2
1874	138.83	6.9003	1.42353	97.5
1879	150.42	7.8622	1.62197	92.8
1884	155.83	8.9583	1.84810	84.3
1889	167.37	10.207	2.10570	79.5
1894	188.70	11.630	2.39927	78.7
1899	225.51	13.251	2.73368	82.5
1904	267.41	15.099	3.11492	85.8
1909	331.41	17.207	3.54910	93.2
1914	389.68	19.590	4.04142	96.5
1919	454.32	22.335	4.60771	98.5
1924	494.34	25.449	5.25013	94.0
1929	550.82	28.997	5.98208	92.1

Solving this straight line equation by the method of least squares, fitted to the five-year price averages, yields the equation:

$$\text{Price} = \frac{\text{Gold (millions of oz. troy)}}{.2063 \times (1.0265)^x}$$

The standard error of this fitted curve (omitting the 1919 Sauerbeck Index) is 11.55 index units and the coefficient of correlation[1] is .835.

From this formula the price levels are computed as noted in Table II. These results are charted as a dashed line on Chart IV for comparison with the actual price level.

The fair degree of correlation of the fitted curve is consistent with the hypothesis, that the rate of money gold accumulation determines world price trends. Moreover, it appears that if this hypothesis is correct, the probable rate of money gold accumulation to maintain the price level is 2.65 per cent per year.

The analysis just concluded has omitted one important factor in the history of world prices. It did not include the influence of money silver. Such an omission is well enough today when its value represents but a very small percentage of the combined stocks of gold and silver. This, however, is a comparatively new situation. At the beginning of the nineteenth century the value of money silver was three times that of money gold, while it was not until 1869 that the value of gold became equal to it. Certainly silver should be included, rather than omitted, as a factor in an analysis of the history of the world prices.

The theoretical curve of prices will now be reworked including with money gold the equivalent value of the existing money silver The new equation to be fitted to the data is:

$$\text{Price} = \frac{G + \frac{S}{r}}{A(1+i)^x}$$

in which:

S = stocks of money silver,

r = silver gold exchange ratio,

$G + \frac{S}{r}$ = equivalent money gold value of money gold plus silver.[2]

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[1] The correlation, as well as those that follow, was based upon direct correlation of the five-year ordinates of the two curves. For the purposes in hand this is deemed more desirable than that of the first differences.

[2] If the combined value of gold and silver were expressed in terms of silver it would change the value of A. The resulting curve, however, would be identical to the one derived.

For the period from 1800 to 1890 the stocks of money silver have been interpolated from the estimates of Jacob, Tooke and Newmarch, in accordance with the principles previously developed. This was done by determining the total stocks retention factor for the period between each estimate and also the period curve for the art stocks. The intermediate five-year periods were then computed and the money stocks taken as the difference.

It will be seen from this that the silver curve of Chart III does not enter into these computations. In its place there is used one which actually passes through the estimates of Jacob, Tooke and Newmarch.

From 1890 to 1924 when the estimate of the United States Mint figure is accepted, the data are interpolated taking into consideration the mint figures for silver coinage and recoinage. This was done by adding to the 1890 money silver stocks the mint figures for world coinage and recoinage and determining the decoinage rate to yield the mint estimate for 1924. The five-year period figures were then computed. For 1929 the mint figures were again used. These money silver figures and also the gold silver exchange ratios appear in Table III.

The equation is now set up as:

$$\text{Log}\left\{\frac{G+\frac{S}{r}}{P}\right\}=\log A+x\log(1+i).$$

Taking the data from Table III and solving this straight line equation by the method of least squares, yields the equation:

$$\text{Prices}=\frac{G+\frac{S}{r}}{0.9563\times(1.01414)^{x}}$$

the origin being at 1800.

The standard error of this fitted curve (omitting the 1919 Sauerbeck Index) is 10.22 index units and the coefficient of correlation .872.

The computed levels of the gold-silver price curves may be noted in Table III. These results are charted as the solid line on Chart IV for comparison with the original Jevons-Sauerbeck and the gold price curves.

Comparing the characteristics of the two curves, it will be seen that the more logical gold-silver curve correlation .872 is statistically slightly superior to the gold curve (correlation .835). The difference is .037 in favor of the former.

The period over which this analysis has been made is so extended

TABLE III

COMPUTED PRICE INDEX BASED UPON THE WORLD'S STOCKS OF MONEY GOLD AND SILVER, QUINQUENNIALLY, 1800-1929

$$\left(P=\frac{G+\frac{S}{r}}{.9563\times 1.01414^{x}}\right)$$

Date	(1) Silver (million oz.)	(2) Exchange ratio	(3) $\left(G+\frac{S}{r}\right)$	(4) 1.01414^{x}	(5) Column (4) times .9563	(6) P
1800	1476	15.68	126.1	1.000000	.9563	132.0
1804	1527	15.41	132.3	1.0574	1.0112	131.0
1809	1589	15.96	134.7	1.1337	1.0842	123.9
1814	1606	15.04	143.8	1.2155	1.1624	123.6
1819	1603	15.83	143.3	1.3033	1.2463	115.0
1824	1605	15.82	142.0	1.4006	1.3394	105.9
1829	1586	15.78	143.2	1.4983	1.4328	100.1
1834	1581	15.74	145.0	1.6176	1.5469	93.8
1839	1660	15.62	152.2	1.7225	1.6472	92.3
1844	1589	15.85	147.4	1.8469	1.7662	83.5
1849	1600	15.78	153.0	1.9802	1.8937	80.7
1854	1674	15.33	184.6	2.1231	2.0303	90.6
1859	1742	15.19	213.1	2.2765	2.1770	97.9
1864	1832	15.37	231.3	2.4408	2.3341	98.9
1869	1967	15.60	253.8	2.6170	2.5026	101.3
1874	2286	16.16	280.5	2.8060	2.6834	104.5
1879	2527	18.39	288.0	3.0086	2.8771	100.0
1884	2763	18.61	304.2	3.2258	3.0848	98.6
1889	3044	22.10	305.6	3.4508	3.3000	92.3
1894	2332	32.56	260.2	3.7085	3.5464	73.3
1899	1713	34.36	275.5	3.9763	3.8026	72.5
1904	1460	35.70	307.9	4.2634	4.0771	75.3
1909	1320	39.74	365.0	4.5711	4.3713	83.5
1914	1129	37.37	421.8	4.9012	4.6870	89.7
1919	1557	18.44	538.3	5.2551	5.0255	107.0
1924	2300	29.38	573.2	5.6345	5.3883	106.2
1929	3220	39.10	633.3	6.0414	5.7774	109.5

that doubt may be raised as to the validity of the analysis. The price indexes of the first part of the eighteenth century might not be comparable with those of more recent date. Again, the money character-

TABLE IV

COMPUTED PRICE INDEX BASED UPON THE WORLD'S STOCK OF MONEY GOLD PLUS MONEY SILVER, QUINQUENNIALLY, 1869-1929

$$\left(P=\frac{G}{.3551\times 1.0208^{x}}\right)$$

Date	(1) 1.0208^{x}	(2) Gold (million oz.)	(3) Column (2) times .3551	Price
1869	4.1387	127.82	1.470	86.9
1874	4.5873	138.83	1.629	85.2
1879	5.0846	150.42	1.805	83.3
1884	5.6359	155.83	2.001	72.9
1889	6.2468	167.37	2.218	75.5
1894	6.9240	188.79	2.459	76.8
1899	7.6745	225.51	2.725	82.7
1904	8.5067	267.41	3.021	88.5
1909	9.4289	331.41	3.348	98.9
1914	10.451	389.68	3.711	105.0
1919	11.584	454.32	4.113	110.2
1924	12.840	494.34	4.559	108.2
1929	14.232	550.82	5.054	109.0

TABLE V

COMPUTED PRICE INDEX BASED UPON THE WORLD'S STOCK OF MONEY GOLD, QUINQUENNIALLY, 1869–1929

$$\left(P=\frac{G+\frac{S}{r}}{1.8806\times 1.0072^x}\right)$$

Date	(1) $G+\frac{s}{r}$	(2) 1.0072^x	(3) Column (2) times 1.8806	(4) Price
1869	253.0	1.6443	3.09227	81.8
1874	280.5	1.7046	3.20567	87.5
1879	288.6	1.7671	3.32321	86.8
1884	304.2	1.8320	3.44526	88.3
1889	305.6	1.8992	3.57164	85.6
1894	260.2	1.9689	3.70271	70.3
1899	275.5	2.0411	3.83849	71.8
1904	307.9	2.1160	3.97935	77.4
1909	365.0	2.1937	4.12547	88.5
1914	421.8	2.2742	4.27686	98.7
1919	538.3	2.3576	4.43370	121.7
1924	573.2	2.4441	4.59637	124.8
1929	633.3	2.5338	4.76506	132.8

istics of the same weights of gold and their silver equivalents at the extremes of this period might be far different. The present money efficiency of gold and silver might be so much greater than a century ago that their actual quantities might represent many times the purchasing power of the former.

In order to investigate this possibility, a study has been made covering the period starting with the year 1869 and terminating as before with the year 1924. The analysis, made in the same manner as was done for the more extended period, yields the curves:

$$P=\frac{G}{.3551\times 1.0208^x}$$

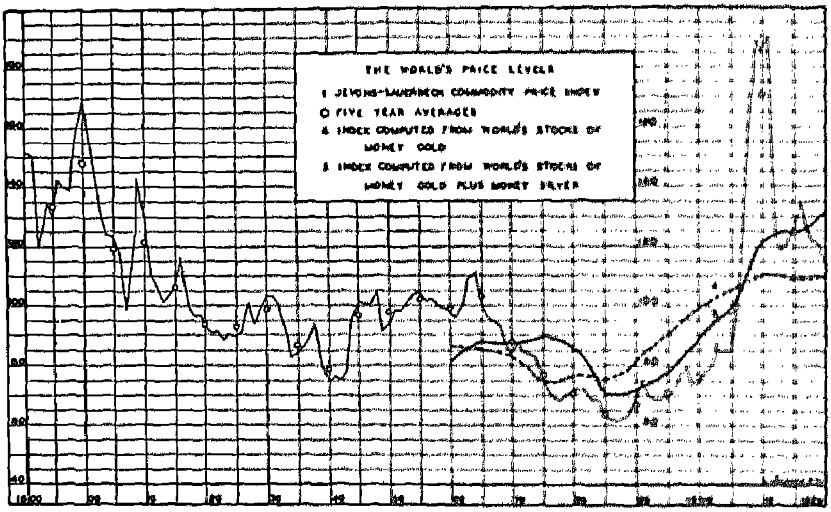
$$P=\frac{G+\frac{S}{r}}{1.8806\times 1.0072^x}.$$

These curves are computed (Tables IV and V) and are charted for comparative purposes. The characteristics for the gold-silver curve are (omitting the 1919 Sauerbeck Index) Standard error, 9.9 index units; correlation .833, while those of the gold curve are (also omitting the 1919 Sauerbeck Index) Standard error, 12.4 index units; correlation .724. (See Chart V.)

It will be seen that as before the more logical gold-silver curve is statistically superior to the gold curve although in this case the superiority is marked, a correlation of .833 against .724 or .109 in favor of the former.

It is of particular interest to note that as a price factor the inclusion of silver in the latter period proves to be more important than over the more extended period. This is because it is during this latter period that gold money was actually substituted for silver. The fact that during this period new money gold has been called upon to replace silver as well as augment its own stock has been overlooked by the gold pessimists. Silver has now been almost entirely replaced by gold so that this dual burden upon gold production is no longer in force.

CHART V



Another assumption in the analysis suggests itself. The equivalent values of gold and silver might not have an equal influence upon prices. This possibility has accordingly been tested. For both periods the silver factor $\frac{S}{r}$ was given first a weight of .9 and then successively .8, .7 and .6. In each case a complete analysis was made determining the price equations; its correlation and its standard error. In order to determine the most probable weight for the silver factor the standard errors, squared for each case, were charted.

The low point in this curve determined the most probable weight for the silver factor. It was learned from this that for the period 1800–1924 a weight of .8 for the silver factor gave the best fitting price curve, while for the period 1869–1924 the weight proved to be .9.

The improvement in correlation, however, was so small that it has not been considered worth while to include these weights in the price formula. For the period 1800–1924 the correlation (omitting 1919) is .899 against .872, or .027 improvement. For the period 1869–1924 the correlation (omitting 1919) is .853 against .833, or a .020 improvement. The only important conclusion to be drawn is that: as a price influence silver has been slightly inferior to its equivalent in gold money.

TABLE VI

STATISTICAL SUMMARY OF CURVES

Period	Curve	Condition	Correlation	Standard error
1804–1924	$P=\frac{G}{.2063\times 1.02645^x}$	....	.681	18.4
" "	" "	(Less 1919)	.835	11.55
" "	$P=\frac{G+\frac{S}{r}}{.9563\times 1.01414^x}$	....	.773	16.1
" "	" "	(Less 1919)	.872	10.22
1869–1924	$P=\frac{G}{.3551\times 1.0208^x}$	....	.69	21.8
" "	" "	(Less 1919)	.724	12.4
" "	$P=\frac{G+\frac{S}{r}}{.18806\times 1.0072^x}$	....	.812	17.09
" "	" "	(Less 1919)	.833	9.9

It has been assumed that the inclusion of the factor of silver (which over either period studied has been a very important consideration in the world purchasing power) is more logical than its omission. The superiority of the curves, which include the silver factor, tends to confirm this assumption. It seems almost certain that these findings warrant the substitution of the gold-silver price theory in lieu of the well-known gold price theory.

The analysis has brought out one more important point. Comparing the two gold formulas it will be noted that in order to maintain the price level throughout the entire century and a quarter, an increase of money gold of 2.65 per cent per year was required. When only the last half of the period was considered the required rate was but 2.08 per cent per year. Thus, due probably to the increased credit efficiency of money, the requirements during the latter period are but 79 per cent of the average for the entire period. Comparing the gold-silver formula in the same manner the requirements drop from 1.414 per cent per year for the entire period to but 0.72 per cent for the latter half. This latter figure is but 51 per cent of the average for the entire period. This is extremely important as it shows the demand for the precious metal money to maintain the price levels of the world has decreased to a remarkable extent during the last century and a quarter. It is needless to remark that the same influence may be carried still further.

Some economists would have the world headed for disaster because they compute that the rate of increase of money gold will be insufficient to maintain the world price level. They base their conclusion upon the premise that for the next decade or so the increase in money gold will be less than 2.5 to 3.0 per cent per year. This analysis is presented solely with the view of modifying these dire predictions.

The writer is very skeptical of any forecast of prices based upon this statistical analysis. The principal conclusion to be drawn is that if the hypothesis of the gold pessimists is amended to include silver money (as it certainly should be) then the present rate of gold production should be a strong cause for rising prices.

For those who would pin their faith upon such a hypothesis, prices should rise as long as the gold value of the stocks of gold and silver money continue to augment faster than 0.72 per cent per year.

FLUCTUATIONS IN EMPLOYMENT IN DETROIT FACTORIES, 1921–1931

By William Haber, *Michigan State College*

The number of workers employed in Detroit factories shows wide seasonal fluctuations in addition to changes resulting from general business conditions. The dominating position occupied by the automobile industry, and the prevalence of important seasonal fluctuations in its operations, are the primary causes for the seasonal ups and downs in the numbers employed in Detroit factories.

The employment statistics upon which this study is based are secured from the Employers' Association of Detroit. In 1920, the Association began the weekly collection of statistics on employment from the most important manufacturing establishments in the Detroit area, in the automobile industry, the metal trades, and scattered, although large, firms in other important industries. During most of the eleven-year period, the reporting firms employed about two-thirds of the employees in the district which includes Detroit, Highland Park, Hamtramck and River Rouge. The reports were secured each Monday morning by telephone at the offices of the Association. The figure reported indicated the number of employees at work on the day of the report. Workers laid-off but still on the payroll were thus, for the most part, excluded. The figures collected were released as the Industrial Barometer for Detroit. As released, the figures indicated the number of workers employed in the reporting factories and made possible a comparison with the preceding week.

With the exception of a short period of time, from May, 1924, to March, 1925, no account has been taken of part-time employment. The weekly figures indicated the number at work on the day of the report without any explanation, except for the brief period noted above of the number of employees working less, or more, than a full week. Information on the amount of part-time work, while of great value to the student and the merchant who were interested in the amount of purchasing power released in the community, was not of particular value to the Employers' Association. The special purpose of an employment barometer to the Association was to discover the fluctuations in the demand for labor so that it may be guided intelligently concerning the steps necessary to adjust the supply. Employment figures were thought of as indicating the "ease" or "tightness" of the labor market. Each Thursday, the different national press services made available the changes in factory employment. When the employment curve showed an upward trend, it served to attract workers to Detroit from all sections of the country. When the barometer indicated that the number employed was decreasing, the Association executives observed a falling off in incoming workers. Thus, the employment barometer provided labor when needed and discouraged labor from coming to the city when the employment opportunities were decreasing. In fact, the Association relied on this barometer to balance labor supply and demand in Detroit, and only rarely have other methods of recruiting been employed.

In February, 1929, the Association discontinued the collection of the weekly figures and ceased publication of the employment chart in its monthly Industrial Barometer. The belief prevailed in some quarters that, when the barometer indicated increasing employment, it tended to make workers restive and increased labor difficulties. When the chart indicated a decreasing amount of employment, business groups in the community thought it caused an unjustifiable degree of pessimism among merchants. The Industrial Department of the Board of Commerce took up the collection of employment figures, but the reports which were made available monthly on an index number basis were not as accurate[1] as the data formerly secured by the Employers' Association. In the following tables and charts the data from 1929 to 1931 are secured from monthly figures collected by the Board of Commerce, but not released for publication.

It will be observed that during the peak in 1929, the reporting factories employed about 300,000 workers. This figure is somewhat more than two-thirds of the factory employees in the Detroit area. Approximately 75 per cent of this total are employed in the automobile industry. Of the number engaged in the other industries listed, namely, tool-making, machine or pattern making, miscellaneous metal parts, brass and aluminum foundries and forges, not a small fraction are engaged on automobile work. As a result of this probably 80 per cent of the workers included in the reports covered in this study are in the automobile industry. But while about 80 per cent of the employment strength represented in the data of the Employers' Association is from the automobile industry, the automobile proportion of the total factory strength in the city is somewhat lower, probably not in excess of 70 per cent.

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[1] Their figures were based partly on the estimates of the number of employees at work, given to the Street Railway Department by the factories in the district.

TREND OF EMPLOYMENT

The rapid development of the automobile industry during the twelve years covered by this study is reflected in the number employed in Detroit factories. With the growth of the industry, the number attracted to Detroit factories which found employment is a constantly mounting one. The depression in 1920–1921 caused a sharp drop in employment from the peak in 1920 to the lowest point recorded in the twelve year period in January, 1921. The number employed increased slowly during 1921, but only after January, 1923, did the number on the payrolls approach the high levels set in the first five months of 1920. The period 1923–1926 was one of intense activity in the automobile industry and the recorded employment totals were higher than at any time in the past. The decrease late in 1926 and in 1927 was sharp, but recovery was rapid. The number at work in 1927 was consistently below 1926. But in 1929 the number employed exceeded the past record and passed the 300,000 mark for the first time in March and April of 1929. Since 1929, as will be more fully discussed below, the decline has been almost continuous.

The trend for the nine-year period to 1929 was upward. After 1920, only 1924 and 1927 showed any decrease in the number employed. The average number of workers employed during each year, excepting 1921, 1924, 1927 and 1930–1931 shows an upward trend. Thus, starting with 1920, when the monthly average of the number of workers employed during the year was 168,787, the increase has been a continuous one. In 1922, the monthly average of the number employed was 156,800; in 1926, the average had increased to 236,138, and reached its highest peak in the Detroit industries in 1929 when the average number employed in these factories was 271,566.

Table I presents the monthly employment in the reporting factories from 1920 to 1931. The original reports, which were made weekly, have been consolidated on a monthly basis.

Examination of the data for twelve years indicates not only the sharp seasonal variations, which are discussed more fully below, but the upward trend in employment between 1920 and 1929. The number employed in the month of greatest activity in seven of the twelve years is greater than in the year preceding. In three years, 1921, 1927 and 1930, for cyclical reasons, the numbers employed in the month of maximum employment is less than in the preceding year. In the twelve-year period, we find that the number employed in the month of greatest activity rose from 198,863 in 1920, to 302,000 in 1929.

Table II compares the trend of employment in Detroit factories with the average for 1923–1925. It will be seen that in 1927, employment showed a considerable drop, but that in 1928, and until October, 1929, the number at work in Detroit factories was constantly greater in comparison to the 1923–1925 average.

MONTHLY FLUCTUATIONS IN EMPLOYMENT

The month of highest employment in 1929 was April, with 302,000 reported at work. In previous years the months of highest employment were March in 1920, August in 1921, July in 1922, May in 1923, February in 1924, November in 1925, March in 1926 and 1927, September in 1928, and May in 1930 and 1931. March and May were the months of highest employment in more years than any other month, each month occurring three times in the twelve-year period.

TABLE I

AVERAGE NUMBER EMPLOYED IN DETROIT FACTORIES, 1920–1931, BY MONTHS*

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
January	......	34,670	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	146,800
February	195,506	50,278	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	174,250
March	198,863	75,311	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	180,300
April	125,926	103,801	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	183,100
May	188,434	116,276	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	184,990
June	188,410	110,916	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	171,480
July	187,605	113,724	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	156,140
August	184,610	117,702	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	136,900
September	177,602	116,022	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	132,800
October	159,084	114,489	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	97,143
November	146,284	113,925	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	113,677
December	104,321	84,928	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	130,784
Average	168,787	96,003	156,800	216,413	210,090	236,503	236,138	206,830	261,661	271,566	169,650	149,887

* The monthly figure in the table is an average of the number reported at work on each Monday of the month. The average for the year is a simple average for the monthly data.

TABLE II

INDEX NUMBERS OF FACTORY EMPLOYMENT, DETROIT, 1920–1931

(1923–1925 = 100)

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
January	....	15.6	44.9	87.6	104.4	92.2	116.9	95.1	97.6	126.9	99.6	66.3
February	88.3	22.7	53.8	94.7	100.1	93.8	120.6	99.0	103.8	133.7	99.7	78.7
March	89.8	34.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	81.5
April	56.9	46.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	82.7
May	85.1	52.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	83.6
June	85.1	50.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	77.5
July	84.7	51.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	70.6
August	83.4	53.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57.3
September	80.2	52.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	60.0
October	71.8	51.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	43.9
November	66.1	51.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	51.4
December	47.1	38.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	59.1

The time of lowest employment is more concentrated about the same month each year. January was the month of least employment for five years, in 1921, 1922, 1923, 1925 and 1928. December was the month of least employment for four years, in 1920, 1924, 1926 and 1930. In other years November was the lowest employment month in 1927 and 1929, and October in 1931.[1]

The variation between the number employed in the most busy month and the least busy month is often very great. Thus 302,000 were employed in April in 1929 in contrast to 204,125 in November of the same year, a variation of 97,875 or 32.4 per cent. The variation in 1928 was 83,284 or 27.8 per cent. In the twelve year period, 1921 and 1931 showed the highest variations: in 1921, 70.5 per cent more workers were employed in August than in January; in 1931, 47.5 per cent more workers were employed in May than in October. The lowest variation is shown in 1927 when only 14.2 per cent more workers were employed in March, the busiest month, as compared with November the month of least employment.

Table III indicates the month of maximum and minimum employment, the number employed in the maximum and minimum months, and the variation between the low month and high month of each year in the period 1920–1931.

There is no indication that seasonal fluctuations are any less sharp in the last few years than at the beginning of the decade.

The average variation for the entire period is 34.3 per cent. Only in 1923 and 1927 were the variations considerably below the average for the twelve years. In terms of numbers of persons employed, the average variation from the month of highest employment is 78,557. Only three years, 1921, 1922 and 1931 are far above this average variation. In other words, irrespective of the numbers employed during the month of greatest activity, about 78,000 persons are removed from the payroll between the busy spring month and the slack winter month each year. In years of business depression the variation in the depression year is considerably greater than that caused by seasonal factors alone. Thus, from July, 1920, to January, 1921, employment dropped 70 per cent. Again from April, 1926, to December of the same year, the number of persons on the payroll decreased 60 per cent.[2]

In 1929 the employment curve began its descent in April, six months before the stock market crash. Except for relatively short periods of time, it has continued to fall since and has reached lower levels than at any time since the 1920–1921 depression. In April of 1929, the factories reported 302,000 employees at work. This was the peak figure in employment in the entire period under review. The decline during 1929 was gradual, but steady. Table I shows that only in the last three months of 1929 was there a substantial drop in employment. In 1930 and 1931, however, the average employment reached lower levels than at any time since 1922. The lowest point reached during the present depression was in October, 1931, with 97,143 workers reported employed. This contrasts with 291,384 in the same month in 1928, and 238,600 in 1929, and 173,400 in 1930.

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[1] The low point of employment for Detroit factories follows closely the production of automobiles for the United States. The low month production of automobiles was January for five years, December for five years, and November for one year. (Computed from monthly data of automobile production in the United States as published in the *Survey of Current Business*, United States Department of Commerce, July 1928, pp. 21–22, and the *Annual Supplement* for 1931, p. 2.)

[2] It might be said that some allowance should be made for the influence of the inventory period at the end of December. But an examination of the figures of Table I indicates that in only five of the twelve years the December figure is considerably below that for November. In fact, in four of the twelve years the December figures exceed those of November, suggesting that the inventory lay-offs are a relatively minor factor.

TABLE III

MAXIMUM AND MINIMUM EMPLOYMENT IN DETROIT FACTORIES, 1920–1930

Year	Maximum		Minimum		Variation from Maximum	
	Month	Number employed	Month	Number employed	Number	Per Cent
1920	March	198,863	December	104,321	94,542	40.8
1921	August	117,702	January	34,670	83,032	70.5
1922	July	182,363	January	99,571	82,792	45.4
1923	May	228,859	January	193,908	34,951	15.3
1924	February	241,603	December	177,302	64,301	26.6
1925	November	266,907	January	204,162	62,745	23.5
1926	March	271,967	December	152,717	119,250	43.8
1927	March	226,099	November	193,891	32,208	14.2
1928	September	299,355	January	216,071	83,284	27.8
1929	April	302,000	November	204,125	97,875	32.4
1930	May	229,875	December	130,000	99,875	43.4
1931	May	184,980	October	97,143	87,837	47.5
Average		229,214		150,657	78,557	34.3

Chart I presents the monthly fluctuations in Detroit factory employment for certain years between 1920 and 1931.

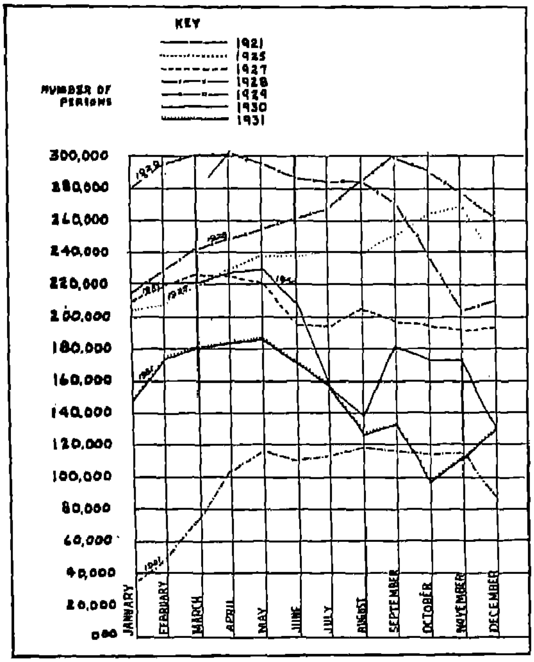
UNEMPLOYMENT IN DETROIT, 1929–1931, AS MEASURED BY FLUCTUATIONS IN EMPLOYMENT AND OTHER DATA

The employment index makes possible only a very rough estimate of the number of unemployed in Detroit. In view of this, a registration of the unemployed was secured late in 1930. In addition to obtaining an estimate of the number of unemployed it sought to gauge the relief needs for the winter immediately ahead. The United States Census provided two counts of unemployment in Detroit, one in April of 1930 and the other in January, 1931. The Metropolitan Life Insurance Company, also surveyed its industrial policyholders and arrived at an estimate of the number of jobless. Since then the estimates must

CHART I

FLUCTUATIONS IN DETROIT FACTORY EMPLOYMENT FOR CERTAIN YEARS

(Based on Table II)



be based on the employment information collected by the Industrial Department of the Detroit Board of Commerce and by the Employers' Association.

The registration of unemployed, one of the first to be undertaken on a city-wide scale in the United States, was conducted by the Mayor's Unemployment Committee on October 7, 8, and 9, 1930, and for some time thereafter. Twenty-eight registration booths were provided in various parts of the city—in schools, election precincts and police stations. The registration followed close upon a heated municipal election, in which much publicity was given to the problem. Newspapers, the radio and other avenues of communication were employed to urge jobless workers to register. The registration during the three days contained 75,400 families, while subsequent registrations brought the total to 102,373. Since many of the registrations represented a family, rather than an individual, the number of unemployed was considerably larger than the total number of registrations. A sample study of the more than 102,000 registration cards indicated that each card represented approximately 1.4 jobless workers. The registrations, therefore, indicated a total unemployment of 143,302 in October, 1930. To this figure should be added those who live in the metropolitan area but work in Detroit. This includes workers in Highland Park, Hamtramck, River Rouge and other surrounding towns. In addition, there is no doubt that a large number did not register for one reason or another.

The census totals differ considerably from the results of the registrations. The April, 1930, census, which was made available after the city registration had been completed indicated that 76,018 workers were in Class A and that 15,479 in Class B, a total of 91,497.

The special census in January, 1931, indicated an astounding increase in the number of jobless. The number of workers wholly without a job totalled 174,527, while 49,041 were on a lay-off, that is in Class B, a total unemployment of 223,568 a figure far in excess of local estimates.

The canvass made by agents of the Metropolitan Life Insurance Company in December, 1930, indicated that among the 42,585 persons in the 9,738 families interviewed only 33.4 per cent of the wage and salary earners were employed full time, 36.4 per cent were working part-time and 30.2 per cent were wholly unemployed. If this percentage were applied to the gainfully employed population of the city, the number of unemployed in December, 1930, totalled about 178,000.

The index of employment as secured from the reporting firms is also of aid in arriving at an estimate of unemployment during the depression. From April, the peak month in 1929, to December, 1931, there has been a reduction in the number employed in the reporting Detroit factories of 171,216 workers. An examination of the index of factory employment from 1929 to December, 1931, indicates the continued drop in factory payrolls since the beginning of the depression.

When the special United States Census was taken in January, 1931, the employment index of the Employers' Association stood at 66.3. At that time the number of unemployed, counting those without a job and those on a lay-off according to the census, was estimated at 223,568. Since January, 1931, however, there has been a further drop in employment. The index fell from 66.3 to 59.1 in December, 1931. Since May, 1931, it fell consistently each month. On the basis of the information contained in Table I, employment since January, 1930, has fallen about 100,000. Since May, 1931, the drop in employment in the reporting factories has been estimated at about 70,000 workers.

One factor in the Detroit situation must, however, be considered in arriving at an estimate of unemployment. The "satchel brigade," the army of transients who come when work is plentiful and leave when work or relief is difficult to secure, is always large in the Detroit picture. The movement of jobless workers out of the city began in the late summer of 1929 and continued throughout 1930 and 1931. Two policies encouraged the exodus. The first was the assurance generally given by employers that any additions to the working force would be made from regular employees with a long service record. The second was the difficulty experienced by those with less than one year's residence in the city to secure relief from the Department of Public Welfare. That many of the unemployed have left the city is evidenced by vacant dwellings, vacant rooming houses, removal of gas and electric meters and similar facts. On the basis of the school census in 1931, the number of single men getting relief from the Department of Public Welfare, and the estimates of employment experts in Detroit, the number who have left the city since January, 1930, is probably about 100,000. When these facts are taken, together with the findings of the special United States Census in January, 1931, the minimum number unemployed in Detroit in December, 1931, was about 175,000.

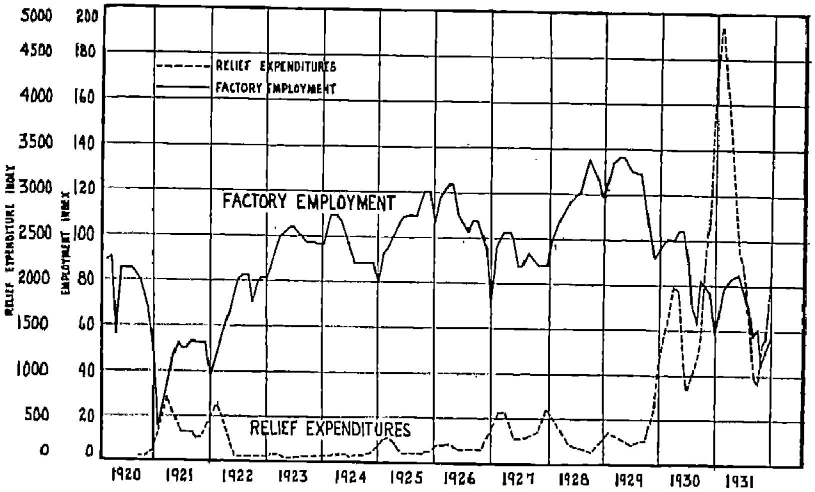
UNEMPLOYMENT RELIEF IN DETROIT

In Detroit the giving of outdoor relief to unemployed or other indigents is centralized in the Department of Public Welfare. Only a very small fraction of the funds of the social service agencies affiliated

CHART II

INDEX OF FACTORY EMPLOYMENT AND RELIEF EXPENDITURES IN DETROIT

Average 1923-1925=100



with the Detroit Community Fund is devoted to direct relief. In normal times, expenditures of the public agency account for about 90 per cent of all the funds spent for relief in the city, but during the present depression, this was true only until July, 1931. Until that time the deficits incurred by the Welfare Department were approved by the City Council. Since then, the Council has limited the Department's expenditures for the fiscal year 1931–1932 to $7,000,000, an amount estimated to be about 70 per cent of the needs.

Table IV presents the relief expenditures of the Department of Public Welfare monthly from September, 1920, to December, 1931, the number of cases receiving relief per month and the average expenditure for each case.

Reference to Table IV indicates that prior to the present depression only for nine months in the entire period from September, 1920, to December, 1929, have the relief expenditures exceeded $200,000 per month. The average monthly expenditure for that period is $80,717.78, while in 1930 the average monthly amount spent for relief was $682,570.06. In 1931 the average reached the total of $897,484.21.

The cost of food always accounts for a great portion of the relief expenditures. In January, 1931, of the total expenditure of $1,812,111.98, food accounted for $1,178,927.20, rent $226,277.89, fuel $197,544.26. In summer months, the rent and fuel items are considerably reduced.

The sudden drop in relief expenditures after July, 1931, is due to a change in policy on the part of the city officials rather than to a decrease in demand for assistance. Definitely limited appropriations to the Welfare Department made it necessary that the funds appropriated be budgeted on a monthly basis and that the expenditures be limited to the appropriation.

As a result of this situation the Welfare Department made drastic cuts in the number of active cases to receive relief, at one time admitting for relief only those families with more than one child and dropping from its lists all single men and women, and all families in which there were no children or only one child. To make unnecessary continuance of this policy, during the winter months, private solicitation of funds were begun in November, 1931.

Table V presents the index numbers of the relief expenditures and the number of active relief cases in Detroit. It has already been seen that there is a striking relation between the fluctuations in employment and the expenditures for relief. Chart II shows this relationship for the twelve year period under review. Relief expenditures have risen during every major depression; they have fallen with the improvement in

TABLE IV

EXPENDITURES FOR GENERAL FAMILY RELIEF AND NUMBER OF CASES DEPARTMENT OF PUBLIC WELFARE, DETROIT, 1920–1931

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
January												
Number of cases.	...	3,794	6,906	1,058	919	2,702	2,055	4,767	5,058	3,250	12,081	46,236
Amount spent..	....	93,347.52	219,064.00	28,363.46	25,972.30	91,285.11	71,186.54	176,755.73	198,303.89	134,983.18	533,992.33	1,812,111.98
February												
Number of cases.	...	8,468	7,184	941	931	2,852	2,188	5,345	4,637	3,160	14,401	47,312
Amount spent..	....	180,778.34	209,222.00	24,394.93	26,630.46	98,991.91	78,261.03	200,229.44	178,839.50	115,759.15	592,468.84	1,581,981.01
March												
Number of cases.	...	10,904	5,615	906	975	2,839	2,217	5,304	4,055	2,904	16,985	45,464
Amount spent..	....	266,226.25	183,656.00	24,869.28	28,957.16	94,789.39	80,854.03	215,997.52	154,666.51	109,017.48	728,069.81	1,448,091.77
April												
Number of cases.	...	7,692	3,040	731	903	1,832	1,792	4,337	2,929	2,545	17,618	38,169
Amount spent..	....	216,886.49	81,253.00	15,855.60	25,139.99	53,764.68	63,725.23	148,005.28	97,036.43	90,625.93	708,956.74	1,120,810.07
May												
Number of cases.	...	5,427	1,505	688	880	1,396	1,608	3,179	2,257	2,277	14,184	31,508
Amount spent..	....	153,218.93	33,899.00	17,941.02	25,204.90	42,947.66	53,137.77	105,476.62	79,937.82	87,503.88	455,525.15	857,939.03
June												
Number of cases.	...	5,232	980	652	837	1,276	1,524	2,690	1,966	2,123	9,935	29,067
Amount spent..	....	121,014.99	21,244.87	16,803.34	22,147.59	40,571.02	56,326.01	98,755.01	64,062.26	79,835.46	305,046.55	806,912.02
July												
Number of cases.	...	4,561	811	606	948	1,205	1,465	2,850	1,853	2,307	10,620	25,330
Amount spent..	....	119,206.09	17,210.85	16,272.93	26,671.31	41,134.63	54,344.55	97,250.98	59,677.10	90,343.98	366,742.91	631,505.88
August												
Number of cases.	...	4,291	749	660	1,050	1,245	1,541	3,084	1,899	2,478	12,555	15,716
Amount spent..	....	115,270.39	16,364.99	17,845.04	29,859.58	40,804.12	52,429.26	116,340.84	62,231.05	92,737.14	425,699.55	360,475.62
September												
Number of cases.	650	4,186	737	647	1,060	1,367	1,415	3,344	1,861	2,628	15,661	12,083
Amount spent..	17,372.51	103,536.01	16,789.93	15,224.12	29,528.87	44,174.33	52,940.40	118,567.21	53,046.61	91,222.46	524,627.59	333,370.72
October												
Number of cases.	692	3,767	772	673	1,189	1,335	1,520	3,533	1,831	3,402	23,152	13,713
Amount spent..	17,698.82	106,432.70	17,716.57	17,597.32	35,985.65	48,142.98	57,465.78	122,195.45	63,639.90	140,655.53	861,477.98	493,808.23
November												
Number of cases.	973	4,389	856	720	1,388	1,367	2,105	4,029	2,134	5,336	30,044	15,600
Amount spent..	25,900.31	126,757.00	19,101.38	20,159.32	42,400.78	48,614.67	74,637.24	156,433.34	75,234.99	218,850.57	1,040,940.80	516,951.26
December												
Number of cases.	1,870	6,073	966	805	1,980	1,710	3,718	5,261	3,189	8,607	39,322	18,200
Amount spent..	47,313.43	178,104.00	25,173.96	24,698.74	69,110.52	64,549.17	137,266.34	211,899.49	105,193.57	402,587.12	1,647,292.48	805,853.03
Average for Year												
Number of cases.	1,046	5,732	2,510	757	1,088	1,761	1,929	3,977	2,806	3,418	18,046	25,976
Amount spent..	27,071.27	148,396.56	71,724.00	20,002.09	32,300.70	59,147.47	64,044.16	147,325.58	99,322.47	137,843.49	682,570.06	897,484.21
Average per case	25.88	25.89	28.58	26.42	29.69	33.59	33.20	37.04	35.40	40.33	37.82	34.55

TABLE V

INDEX OF EXPENDITURES FOR GENERAL FAMILY RELIEF, DEPARTMENT OF PUBLIC WELFARE, DETROIT, 1920–1931

(Average 1923–1925 base)

	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
January	.....	251.27	589.67	76.35	69.91	215.72	191.62	475.79	513.79	263.25	1,487.33	4,077.01
February	.....	486.62	663.18	65.88	71.88	188.48	210.88	536.67	481.46	311.60	1,504.08	4,258.35
March	.....	716.62	494.36	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	275.45	1,554.40	3,867.59
April	.....	583.77	218.72	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	243.04	1,308.30	3,018.98
May	.....	412.43	91.25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	235.54	1,224.19	2,790.29
June	.....	325.74	57.19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	214.09	871.12	2,177.04
July	.....	320.88	46.33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	243.13	967.19	1,929.53
August	.....	310.28	44.05	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	249.83	1,143.66	970.34
September	46.76	278.70	45.19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	245.55	1,417.18	997.24
October	47.64	286.49	47.69	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	378.01	2,314.91	1,329.21
November	69.72	341.20	51.42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	580.10	2,861.09	1,591.52
December	127.36	479.42	67.76	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1,083.65	4,434.15	2,160.13

employment conditions, although several seasonal increases in employment also show increases in relief, and are probably explained by the labor surplus resulting from the large army of incoming workers.

A FIELD STUDY OF THE DIFFERENTIAL BIRTH RATE

By Herbert S. Conrad and Harold E. Jones, *Institute of Child Welfare, University of California*

The present study is concerned with the relation between two sets of variables: (a) the intelligence, education, and social status of parents and children; and (b) size of family, age of mothers at child-birth, and natal interval between children. Earlier studies have presented the facts concerning conditions of data-collection, suitability of intelligence tests employed, and fairness of sampling within the communities investigated.[1]

For the measurement of intelligence, the Stanford-Binet test was applied to children, the Army Alpha to adults. Size of family and age of parents and children were determined by interview, questionnaire, or reference to town clerks' records. The child-bearing period of each mother in the completed families[2] was computed by subtracting the age of the youngest child from the age of the eldest. Natal intervals between successive offspring were also computed, except in the rather small number of cases for which some uncertainty existed concerning the birth rank of the children involved. Additional data include the education of the parents (obtained through interview or questionnaire) and an average "social status" rating of the family. The social status ratings were made on a nine-point scale[3] by two or three presumably

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[1] Acknowledgments are due to Professors A. T. Poffenberger and R. S. Woodworth for administrative assistance; and to the Social Science Research Council of Columbia University for a grant-in-aid of field work covering 19 towns in rural Vermont, Massachusetts and New Hampshire. For details of sampling and test-administration, see H. E. Jones, "A First Study of Parent-Child Resemblance in Intelligence," *The 27th Yearbook of the National Society for the Study of Education*, 1: 61–72; and H. E. Jones, et al., "Psychological Studies of Motion Pictures," *University of California Publications in Psychology*, 3: 225–284. A detailed description of the sampling characteristics of the present group, with reference to the variables discussed in the present paper, will be presented in a forthcoming paper.

[2] Division into completed and uncompleted families was made on the basis of mother's chronological age, the age of offspring, and the period without childbirth. The oldest mother in the uncompleted families was 45 years; her first child was ten years old, her second was six. The two youngest mothers in the completed group with husbands living at home, were both 38 years; neither of these had had any children for twelve years. Statistical constants:

	Completed families				Uncompleted families			
	n	Mean	Median	S.D.	*n*	Mean	Median	S.D.
Age of mother	59	45.2	44.5	5.83	77	32.8	32.6	4.72
Age of father	40	40.1	49.5	6.69	74	37.4	35.8	6.38
Age of eldest child	59	10.3	10.4	5.59	96	11.4	11.3	3.96

See also Table VIII.

[3] The rating scale, and details concerning validity, will appear in a forthcoming article.

competent judges, such as a town clerk, or a local physician or minister.

Information concerning each of the items above was not always available for every member of every family; this explains the inequality in number of cases in the following tables. Another cause of discrepancy is the fact that for certain treatments all families could be employed; whereas in other treatments, only "full" families (parents and siblings) could be used. Most of the families include both parents and children, but in somewhat over ten per cent of the cases, data is available for the sibship only.

In order to eliminate the disturbing factors involved in correlations with age, the raw Alpha and Stanford-Binet scores were converted into sigma- (standard-deviation-) scores for each age group, on the basis of a larger sampling consisting of over a thousand Alpha tests and nearly four hundred Stanford-Binets;[1] these sigma scores are used throughout the present article. Zero correlations of the sigma scores of mothers, fathers, and children with chronological age, are among the indications that the sample of the present study is unselected, with reference to the larger total sample from which it is taken.

In part, eugenists base their argument of racial deterioration on the premises that unintelligent women are marrying earlier than intelligent, are bearing children over a longer span of years, and are having children with a shorter interval between the successive births. It is also sometimes suggested that through physiological factors connected with age at pregnancy, the children of older mothers may suffer a handicap; social conditions promoting later marriage would therefore have a direct dysgenic effect. The following tables present relevant data for our rural New England sample. From Tables I and II it can be seen that apparently the upper classes do begin to bear children

TABLE I

CORRELATIONS WITH AGE OF MOTHER AT BIRTH OF FIRST CHILD

(Completed plus Uncompleted Families)

Line no.	Age of mother at birth of first child X	*n*	*r*
1.	Intelligence of mother	129	+.14 ± .058
2.	Intelligence of father	110	+.23 ± .061
3.	Education of mother	99	+.17 ± .066
4.	Education of father	79	+.20 ± .073
5.	Social status of family	123	+.22* ± .058

* In our sample, social status is positively related with age of mother to the extent of about +.20; for this reason, the *r* of +.22 is reduced when age is partialed out. Calling mother's age at birth of first child 1, social status 2, and mother's present age (i.e., age at the time of our survey) 3, we have computed: $r_{12} = +.22$; $r_{13} = +.70$; $r_{23} = +.20$; and $r_{12.3} = +.12$.

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[1] H. E. Jones, "A First Study, etc.," *op. cit.* Not all these cases of the larger sampling could be used in the present study, due to the absence of necessary data (such as intelligence tests of siblings or parents of the testee, information enabling the classification into completed vs. uncompleted families, etc.).

somewhat later than the lower. But so far as can be judged (Table III) the children born to older mothers are not less gifted in intelligence than those born to younger;[1] further (Tables IV and V), the average period of child-bearing is no less among the intelligent than among the unintelligent; and the average natal interval is no greater.

TABLE II

CORRELATIONS BETWEEN PARENTAL INTELLIGENCE AND MOTHER'S AGE AT CHILD-BEARING

Line no.	Intelligence of mother ×	*n*	*r*	Intelligence of father ×	*n*	*r*
1..........	Age of mother at 1st child	129	+.14 ±.058	Age of mother at 1st child	110	+.23 ±.061
2..........	Age of mother at 2nd child	117	+.23 ±.059	Age of mother at 2nd child	99	+.27 ±.063
3..........	Age of mother at 3rd child	82	+.14 ±.073	Age of mother at 3rd child	68	+.18 ±.079
4..........	Age of mother at 4th child	43	+.25 ±.096	Age of mother at 4th child	36	+.23 ±.106

TABLE III

CORRELATIONS BETWEEN AGE OF MOTHER AT CHILD-BEARING AND INTELLIGENCE OF CHILDREN

(Completed plus Uncompleted Families)

Line no.	Correlation between	*n*	Raw *r*	Factor held constant	Partial *r*
1...............	Age of mother at birth of first child × av. intell. of sibship	129	+.14 ±.058	Mother's intell.	+.08 ±.059
2...............	Age of mother at birth of each child × child's intelligence	306	+.16 ±.033	Mother's intell.	+.12 ±.033

Thus far, all our data point to the probable absence of any relation between number of offspring and intelligence of parents or siblings. Table VI presents the facts for the completed families. From this table, it actually seems that size of family is related *positively* to certain desirable social traits; the correlations, however, are not reliably greater than zero. Before the zero relationship may be accepted, however, it is necessary to know (1) whether the uncompleted families are less intelligent than the completed, and (2) whether the size of uncompleted families will eventually exceed that of the present completed. From Table VIII it can be seen that the difference between the two types of families, in regard to present size of family, is not very large; this sug-

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[1] A question of subsidiary interest is whether the more intelligent parents give birth to the *majority* of their children within any particular five- or ten-year period (such as ages 20–25, or 20–30). Table IV does not answer this question directly, though it predisposes one to a negative expectation. Tables II and V virtually do answer the question directly—and the answer, for the rural New England communities of this study, is negative. Table III—within the limits of the P.E.'s —dismisses the question as having little or no eugenic importance so far as intelligence is concerned, although the question still retains considerable psychological and sociological interest.

TABLE IV

CORRELATIONS WITH SPAN OF THE CHILD-BEARING PERIOD

Line no.	Child-bearing span * X	n *	r
1	Intelligence of mother	53	+.03 ± .09
2	Social status	53	−.06 ± .09

* Child-bearing span can be determined, of course, only for the completed families in which both age of eldest and age of youngest child are known. In the case of completed families of only one child, the child-bearing span was counted as 0 years.

TABLE V

CORRELATIONS WITH NATAL INTERVAL

Line no.	Average natal interval* X	Completed families		Uncompleted families	
		n	r	n	r
1	Intelligence of mother	49	+.08 ± .10	67	.00 ± .08
2	Intelligence of father	39	+.04 ± .11	63	−.01 ± .09
3	Education of mother	36	−.20 ± .11	52	−.11 ± .09
4	Education of father	35	−.21 ± .13	47	−.17 ± .10
5	Social status of family	52	+.30 ± .09	83	+.04 ± .07
6	Average	..	+.002	..	−.050

* Mean of the natal interval between consecutive children in a family. It is interesting to note that among the completed families, with size of family held constant, the natal interval between later pairs of children is on the average slightly shorter than between earlier pairs. Among uncompleted families, [illegible]

gests (as might be inferred from a priori considerations respecting sampling) that the present uncompleted families will eventually be larger than the completed. But our evidence fails to indicate any inferiority of intelligence for the uncompleted, as against the completed, families.

Although the data are obviously less appropriate, it is nevertheless

TABLE VI

CORRELATIONS WITH SIZE OF FAMILY

(Completed Families)

Line no.	Number of offspring X	Completed families	
		n	r
(1)	(2)	(3)	(4)
1	Intelligence of mother	55	+.05 ± .09
2	Intelligence of father	45	+.30 ± .10
3	Education of mother	41	+.07 ± .11
4	Education of father	31	+.22 ± .12
5	Social status of family	58	+.03 ± .09
6	Average intelligence of sibship	61	+.18 ± .08
7	Average	..	+.13

tempting to examine the relation between size of family and intelligence among the uncompleted families. This relation is negative (Table VII). But we have previously seen that the less intelligent begin to bear children sooner than the more intelligent (Table I); this fact, perhaps, accounts for the larger size of the less intelligent of the uncompleted families, while they are still uncompleted. In time, however, this initial advantage will be erased by the eventual equality of the total period of child-bearing among intelligent and unintelligent (Table IV). It therefore seems desirable to equate the period of child-bearing *to date*, among the uncompleted families; this may be done by holding constant the age of the eldest child.[1] The partial correlations which effect this are presented in column 5 of Table VII. These are the coefficients (for the uncompleted families) properly to be compared with those of Table VI. Our conclusion from Tables VI and VII is that in the completed family of the rural districts here studied, number of offspring is not significantly or reliably related to intelligence.[2]

TABLE VII

CORRELATIONS WITH SIZE OF FAMILY

(Uncompleted Families)

Line no.	Number of offspring ×	Uncompleted families		
		n	*r*	Partial *r*†
(1)	(2)	(3)	(4)	(5)
1	Intelligence of mother	68	−.21 ±.08	−.16
2	Intelligence of father	62	−.32 ±.08	−.22
3	Education of mother	53	−.21 ±.09	−.15
4	Education of father	49	−.17 ±.09	+.03
5	Social status of family	66	−.37* ±.07	−.30*
6	Average intelligence of sibship	68	−.20 ±.08	−.19
7	Average	..	....	−.17

* This coefficient, the lowest in its column, may indicate that a small family promotes superiority of social status, as well as vice versa.

† Age of eldest child being held constant; for explanation, see text.

Our evidence, then, seems to support the belief that in the rural sections investigated, family size is non-differential. But the lower classes may still achieve a higher rate of increase by diminishing the interval between generations, or (shall we say) by increasing the turnover. In the present instance, this last-mentioned differential is extremely meager. Between the mother with an intelligence score at the bottom of the distribution and the mother with an intelligence score toward the top, the difference in age at birth of first child is, on the average, only about three years (computed from the regression between intelligence and age-at-first-child, see Table I). A similar relation holds between intelligence and mother's age at the birth of later children (Table II). It must be remembered, moreover, that the slight advantage which the lower classes in the present study derive through somewhat earlier reproduction, may easily be counterbalanced (if not more than counterbalanced) by a higher death rate in maturity.

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[1] The correlations between number of offspring in the family and age of eldest child are +.62 and +.33 for the uncompleted and the completed families, respectively. Holding constant the age of eldest child would not affect the correlations for the completed families in Table VI by more than about .01.

[2] To a small extent, this absence of relation may arise through the migration cityward of intelligent and ambitious individuals who, even had they remained in the country, might still have limited the size of their families quite severely. The converse possibility, namely, migration to city slums by indigent persons with an incurable tendency toward large families, also suggests itself for consideration. It seems to us improbable, however, that either one of these possibilities involves a sufficient number of cases appreciably to affect our fecundity-intelligence correlations.

One additional point deserves mention. The average size of family in the present study is certainly smaller than would have been found in a study of New England pioneers. Given a positive relation between intelligence and birth-position in family, declining family size would adversely affect the intelligence of the race. But it has been previously demonstrated, at least for the present rural sample, that the later births of large families are no more intelligent than the earlier-born.[1]

TABLE VIII

STATISTICAL CONSTANTS

Refer to		Variable	Completed plus uncompleted families							
Table	Line		n	Mean	Median	S.D.				
1	1	[illegible]	129	23.9	22.7	5.39				
2	2	[illegible]	117	26.5	25.7	5.34				
2	3	[illegible]	82	29.3	28.4	5.18				
2	4	[illegible]	43	31.2	30.1	4.84				
3	2	[illegible]	398	27.6	26.8	6.27				
			Completed				Uncompleted			
			n	Mean	Med.	S.D.	n	Mean	Med.	S.D.
6, 7	1	Number of offspring	55	3.55	3.18	1.79	68	3.00	2.78	1.51
5	1	Average natal interval, in months	49	42.5	36.8	18.5	67	35.0	29.8	16.6
4	..	Child-bearing span	53	8.4	6.7	3.54	.....	.....	.....	.....

Table VIII presents statistical constants for certain of the variables which appear in the preceding tables.

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[1] H. E. Jones and H. H. Hsiao, "A Preliminary Study of Intelligence as a Function of Birth Order," *Journal of Genetic Psychology*, 35: 428–433, 1928. Additional evidence, and a review of the literature, may be found in H. H. Hsiao, "The Status of the First-Born with Special Reference to Intelligence," *Genetic Psychology Monographs*, 9: Nos. 1–2, 1931.

SUMMARY

The data of the present study consist primarily of intelligence tests administered to children and adults in rural New England, together with information concerning size of family and other variables of interest to the eugenist. Part of the value of the study derives from the special precautions taken to insure fairness of sampling. Tables I and II indicate that the more intelligent parents begin to give birth to children slightly later than the less intelligent; the children born to older mothers, however, appear to be just as intelligent as those born to younger, when intelligence of mother is held constant (Table III). The period of child-bearing is equally long among intelligent and unintelligent (Table IV); as is also the average natal interval between successive offspring (Table V). Tables VI and VII indicate that, for completed families of the community investigated, no significant relation exists between living number of offspring and such variables as parental intelligence, education, and social status. It is concluded that family size is non-differential; but the earlier child-bearing (or shorter interval between generations) of the lower classes, gives to these classes an advantage in respect to rate of increase. This advantage, however, is very slight, and is probably to a large extent counterbalanced by a differential death rate in maturity.

Care should be taken not to generalize too broadly from the results of the present study of rural districts. The results do, however, suggest that within a given cultural group, deliberately fostered eugenic procedures may be less essential than commonly supposed.

VARIATION IN THE DURATION OF MARRIAGES WHICH END IN DIVORCE, WITH SPECIAL REFERENCE TO THE STATE OF WISCONSIN[1]

By Kimball Young and C. L. Dedrick, *University of Wisconsin*

This study aims to analyze the changes in the duration of marriages which end in divorce. The data are drawn from the State of Wisconsin. Three major problems presented themselves to the writers: (1) For the divorced population has the length of marriage increased or decreased since 1887? (2) What is the effect of out-of-state marriages upon the duration of marriage among those who are divorced? Are any revealed differences statistically significant? (3) Has the variation in duration been correlated both with changes in the period from marriage to separation and with changes from the period of separation to divorce? Or has it arisen from only one of these two variables?

The data for this study were taken from two sources: (1) the United States Census publication, *Marriage and Divorce: 1867–1906*, Part I, and (2) the divorce records of the Wisconsin State Bureau of Vital Statistics for 1929. Some question may be raised concerning the accuracy of the data for the earlier years. Unfortunately there is no method of checking these figures. The data for 1929, however, were taken from the files of the Wisconsin Bureau of Vital Statistics from the records turned into the Bureau by the separate counties. The entire universe of data for the two periods was used.

In order to make a more detailed classification of various periods of marital duration for the 1929 divorces the length of marriage was computed to years and months. The census data for 1887 to 1906 did not permit this refinement. Except for the class interval "under one year duration," the early study merely subtracted calendar years to determine the duration periods. The census publication, therefore, centers each tabulation class interval on the exact year. The present study centers it at the mid-point of the class interval.

(1) Our first problem was to discover if the total duration of marriages ending in divorce in Wisconsin had increased or decreased when the figures for 1887–1906 are compared with those of 1929. We know that the rate of divorce in this state is increasing. For 1868–1872 divorce per 1,000 of the total population was .38, the corresponding

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[1] The writers are indebted to Mr. L. W. Hutchcroft of the Bureau of Vital Statistics at Madison, Wisconsin, for access to the 1929 data. They also wish to express their appreciation of the research grant from the University of Wisconsin Graduate School which made this study possible.

figure for 1898–1902 was .65, and for 1926–1929 it was .86.[1] Also for 1898–1902 the number of divorces per 1,000 of the married population was 1.80, and for 1926–1929 it was 2.19. Yet these figures do not give us data on the total duration of the marriages which terminated in divorce. From our own sources, however, we were able to determine this. Table I gives the duration of marriages ending in divorces in Wisconsin for 1887–1906 and for 1929, with a conversion to base 1,000 for comparative purposes.

TABLE I

DURATION OF MARRIAGES ENDING IN DIVORCE IN WISCONSIN, 1887–1906,* AND 1929, WITH RATIOS PER 1,000

Number of years married	1887–1906		1929	
	Number	Ratio per 1,000	Number	Ratio per 1,000
I	II	III	IV	V
All	22,498	1,000	2,651	1,000
Under 6 months	....	....	38	14.3
Under 1 year	621	27.6	125	47.1
1	908	40.4	208	78.5
2	1,860	82.7	236	89.0
3	1,756	78.1	206	77.7
4	1,656	73.6	176	66.4
5	1,528	67.9	187	70.5
6	1,365	60.7	168	63.4
7	1,194	53.1	101	38.1
8	1,109	49.3	150	56.6
9	963	42.8	124	46.8
10	890	39.6	100	37.7
11	889	39.5	72	27.2
12	708	31.5	78	29.4
13	689	30.6	61	23.0
14	627	27.9	59	22.3
15	534	23.7	59	22.3
16	503	22.3	52	19.6
17	486	21.6	54	20.4
18	441	19.6	37	14.0
19	388	17.2	47	17.7
20 and over	3,383	150.4	351	132.5
20–24	....	....	156	58.8
25–29	....	....	114	43.0
30–34	....	....	57	21.5
35–39	....	....	15	5.7
40–44	....	....	4	1.5
45–49	....	....	2	0.8
50–54	....	....	2	0.8
55–59	....	....	1	0.4
Mean duration of years	10.37		9.83	
Standard deviation	8.39		8.26	

* *Marriage and Divorce, 1867–1906*, Part I, p. 108.

The table reveals clearly that the 1929 ratios are generally higher for the shorter durations while the 1887–1906 ratios are higher for the longer ones. Does this indicate that proportionately more divorces are granted in the shorter duration periods now than during the earlier period? The mean number of years married for each series and the standard deviation are given in Table I. The standard error[1] of the difference between the means is .1688. In short, the evidence seems rather conclusive that this difference in duration is significant and that it represents a trend in Wisconsin, at least, toward shorter duration of marriages which end in divorce.

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[1] See *Marriage and Divorce, 1867–1906*, Part I, p. 16.

(2) If we examine the duration of the out-of-state marriages we may be able to answer the second principal question which we set ourselves regarding the effect of out-of-state marriages upon divorce. Table II furnishes us the data for this comparison. It shows the number of

TABLE II

THE NUMBER OF WISCONSIN DIVORCES FOR 1929 OF EACH KNOWN DURATION, BY RESIDENCE AT THE TIME OF MARRIAGE, AND THE PLACE OF MARRIAGE

Number of years married	Both parties residents of Wisconsin at time of marriage		All others *
	Married in Wisconsin	Married in surrounding states	
I	II	III	IV
All	1,270	670	701
Under six months	15	18	5
Under 1 year	56	51	17
1	85	83	40
2	103	79	54
3	81	84	43
4	71	68	37
5	90	52	44
6	68	47	63
7	43	28	30
8	69	32	49
9	59	28	38
10	36	23	41
11	38	15	19
12	35	14	28
13	41	7	13
14	40	5	14
15	29	6	24
16	25	9	18
17	32	8	14
18	26	4	6
19	28	4	15
20–24	91	15	49
25–29	83	7	25
30–34	35	..	22
35–39	12	..	3
40–44	1	1	2
45–49	1	..	1
50–54	..	..	2
55–59	1	..	2
Mean duration	10.561	5.772	10.536

* This classification includes cases where one or both parties were residents of other states at the time of marriage but regardless of place of marriage and a few cases of Wisconsin residents who were married in other states or abroad.

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[1] Some question might be raised regarding the use of the standard error of the difference with data in skewed distributions. Both the 1887–1906 and the 1929 distributions are skewed in the same direction and to approximately the same degree. (The skewness for the former distribution is .396, for the latter it is .358, computed by Yule's method of approximation.)

marriages of residents of Wisconsin which were contracted within the state itself, or in one of the four neighboring states of Illinois, Iowa, Minnesota, or Michigan. Column IV includes cases where one or both persons were residents of other states at the time of marriage regardless of place of marriage and a few cases of Wisconsin residents who were married in other non-contiguous states or in foreign countries.

The general averages computed for this table are significant, but they can easily be explained. The existence of good roads and automobiles makes marriage in neighboring states almost as convenient as at home. Surrounding states are a mecca for those seeking easy marriage and avoidance of the law. Two marriage laws in Wisconsin have led to a great deal of evasion. The first law, passed in 1899, requires a five-day waiting period between the date of application for a license and the date of issuance. The second, passed in 1913, requires a physical examination for all males who apply for a marriage license.[1]

If migration for marriage is a comparatively recent phenomenon then it would be unfair to compare the data in columns II and III of Table II. There could not possibly be as many marriages of long duration in the out-of-state series as in the in-state series. It would seem best therefore to limit the comparative analysis of these two series to a shorter interval of time.

For this purpose a separate analysis was made of marriages which were contracted during the ten-year, and the five-year periods ending in 1929. These data are presented in Table III.

TABLE III

IN-STATE AND OUT-OF-STATE MARRIAGES OF TEN YEARS OR LESS, AND OF FIVE YEARS OR LESS DURATION, 1929 *

	In-state	Out-of-state
Number of marriages of a total duration of 10 years or less....	761	575
Mean number of years..................................	4.99	4.40
Standard deviation....................................	2.94	2.79
Number of marriages of a total duration of 5 years or less.....	486	417
Mean number of years..................................	3.11	2.96
Standard deviation....................................	1.63	1.57

* *Vide* Table II, columns II and III.

The difference between the means of the series of ten years or less is .59 years. That is, the average marriage of Wisconsin residents who were married in the contiguous states and who also secured a divorce within ten years after marriage was six-tenths of a year shorter than marriages of Wisconsin residents who were married in the state and who also secured divorces here within the same ten-year period. The standard error of the difference between the two means is .1580.

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[1] See *Wisconsin Statutes, 1929:* Sections 245.10 and 245.14. It is often believed that the law in regard to physical examinations is not enforced. Although the examination itself may be perfunctory a physician's certificate is insisted upon. Many persons resent the idea of a compulsory examination and object to the physician's fees.

If an analysis is made of marriages contracted during the five-year period ending in 1929, the difference between the mean number of years married for in-state and out-of-state cases is only .15 with a standard error of the difference of .1067. This decrease in the difference between in-state and out-of-state marriages for the shorter period may be accounted for in either of two ways. First, the trend toward more out-of-state marriages may have greatly affected the marriages of shorter duration. It is impossible with the present data to check statistically this assumption. Second, it is quite possible that in the short-time marriages ending in divorce there may be many more common causal factors in in-state and out-of-state marriage groups than is true of long-time marriages which end in divorce. In other words, in the latter group there may be differentials in legal causation which do not operate in the former. Further statistical analyses in terms of legal causes for the two types of marriage must be made before any definite conclusion can be drawn.

We have not made an exhaustive analysis of the problem, but a tabulation of in-state and out-of-state marriages which end in divorce, indicates in general for Wisconsin that in counties adjacent to neighboring states there is a much higher percentage of out-of-state marriages than in the counties in the central section. It is also apparent that urbanization of population is a factor since the rate is also high for those counties bordering or near Lake Michigan. These are the counties with the largest urban population.

The writers hope to make a more careful analysis of this aspect of the problem. Such variables as urbanization, the existence of trunk highways leading toward neighboring states, the matter of religious affiliation and divorce, and other items must be investigated before any final conclusion can be reached.

(3) Another fact brought out by this study is the lag in time between separation and divorce. Existing laws set a certain minimum on the duration of marriage before a divorce may be granted. Perhaps the "duration" which should be studied is the period from marriage to separation rather than from marriage to divorce. There must be great variability in this matter. Some couples separate permanently shortly after marriage and yet may wait years before securing a divorce. Others separate only after a long period of marriage and wait only a month or even less before filing suit for divorce.

This period from marriage to separation is very important in any investigation of family disorganization. Mowrer's comment on family organization and family break-down is in point. He says:

> The establishment of a family is the process of building up organized attitudes in which all concur. Family disorganization represents the converse process in which the family complex breaks up and the ambitions and ideals of the individual members of the family become differentiated. The legal aspects of marriage and divorce are recognition by the community or state that family attitudes have been established or discontinued, i.e., disintegrated.[1]

In our present culture marriage doubtless more nearly marks the organization of the family complex than does divorce mark its disorganization. Sociologically marriage is the usual evidence of the inception of family organization as such. Separation, particularly the final separation after which the husband and wife no longer share bed and board, more nearly denotes overt family disintegration than does the legal divorce itself.

With this in mind let us analyze the lag between separation and divorce. Table IV presents a comparison of the years of lag between separation and divorce as reported for 1887–1906 and for 1929. For the first period, the average duration from marriage to divorce was 10.4 years. From this table we find that for the same period the average duration from marriage to separation is 7.7 years and that the average duration from separation to divorce is 2.7 years. In like

TABLE IV
KNOWN YEARS BETWEEN SEPARATION AND DIVORCE, 1887–1906 AND 1929

Known years	1887–1906		1929	
	Number	Per 1,000	Number	Per 1,000
	I	II	III	IV
All	18,183	1,000	2,329	1,000
Under 6 months	...	...	845	...
Under 1 year	3,213	176.7	1,305	560.3
1	5,113	281.2	437	187.0
2	3,754	206.5	231	99.2
3	1,959	107.7	122	52.4
4	1,135	62.4	68	29.2
5	792	43.6	49	21.0
6	591	32.5	36	15.5
7	402	22.1	15	6.4
8	268	14.7	17	7.3
9	197	10.8	15	6.4
10–14	514	28.3	17	7.3
15–19	145	8.0	15	6.4
20–24	...	...	1	.4
25–29	...	...	..	..
30–34	...	...	1	.4
20 and over	100	5.5	2	.8
Mean duration from marriage to separation	7.7		8.1	

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[1] Ernest R. Mowrer, *Family Disorganization*, Chicago, 1926, p. 4.

manner we know that for 1929 the average duration from marriage to divorce is 9.8 years; the average period from marriage to separation is 8.1 years; thus, the average period from separation to divorce is only 1.7 years. In other words, *the average period between marriage and separation has increased in the past thirty years, and the period between separation and divorce has considerably decreased.*

What factors may account for this trend? Why should the number of years from marriage to separation have increased? Why should the period from separation to divorce have decreased more than one-third? A number of pertinent considerations present themselves.

In the first place, divorce is now much more openly approved than it was in the twenty-year period from 1887 to 1906. There seems to be less hesitancy about getting a divorce on the part of married couples who have separated. Furthermore the possibility of a divorce as a way out of marital difficulties seems to be much more commonly accepted today among married people than formerly. So, too, the possibility of greater mobility enables married persons more easily to get away from each other and from their acquaintances. Again the gainful employment of women outside the home provides an alternative to the continuance of an odious marriage relationship. And, finally, the possibility and ease of getting married again may stimulate divorce. Former taboos against re-marriage have disappeared, and in certain classes of our population re-marriage after divorce may be said to be in the mores. These factors, and others, undoubtedly contribute to shortening the period between marriage and divorce. On the other hand we must look further to discover why the period from marriage to separation has increased.

The following hypothesis in answer to this question may be open to criticism but to the writers it seems to be the most reasonable explanation of this fact. It is probable that the number of married couples applying for divorce is increasing among the older as well as among the younger married people. Since these persons are older their marriages are, on the average, of longer duration. If many of these longer-duration marriages end in divorce after only a brief period of separation, they would contribute proportionately more to the duration from marriage to separation, and to the total duration, than to the time from separation to divorce.

This raises the question: Do people who have been married and have lived together for many years get divorced after so brief a period as those who are married for a shorter length of time? Table V gives the quartile deviations of the number of years from separation to divorce for Wisconsin, 1929.

The lower quartiles are fairly uniform showing no definite increase with longer durations. Approximately 25 per cent of all divorces of the longer duration groups are divorced about as soon after separation as a like per cent of the shorter total duration groups. Likewise the medians and the upper quartiles show no definite increase with longer periods of married life. We may say that almost regardless of the number of years Wisconsin couples have lived together, if they decide to secure a divorce, 25 per cent of them will be divorced within about four and one-half months after the final separation, 50 per cent within a year and 75 per cent within two years and eight months.

TABLE V

NUMBER OF YEARS FROM SEPARATION TO DIVORCE IN WISCONSIN FOR 1929

Number of years married	All	Median and quartile deviations in years		
		Median	Quartile 1	Quartile 3
All	2,329	....	...	....
0–5 months	33	....	...	....
6–11 months	77	....	...	....
1 year	188	.62	.32	1.16
2	207	.92	.36	1.69
3	186	1.04	.42	2.12
4	158	.96	.45	2.34
5	172	.79	.32	1.87
6	145	.92	.36	2.46
7	86	1.08	.42	2.73
8	139	.76	.31	2.57
9	114	.94	.40	2.68
10	86	.93	.38	2.21
11	63	.92	.42	2.41
12	74	.83	.36	1.97
13	48	1.00	.43	2.00
14	51	.79	.32	2.13
15	52	1.43	.44	4.00
16	40	.94	.40	4.58
17	47	1.50	.46	3.45
18	32	.75	.39	2.50
19	31	.59	.31	1.85
20–24	128	.75	.25	2.89
25–29	102	.88	.34	2.88
30–34	45	2.13	.53	6.25
35–39	10	....	...	....
40–44	4	....	...	....
45–49	..	....	...	....
50–54	1	....	...	....
55–59	1	....	...	....

The legal minimum set for the different causes of divorce has very likely more weight in determining the interval between separation and divorce than the length of the period between marriage and separation. This suggestion should be tested by a more complete analysis of the lag in terms of legal "causes" for divorce action.[1]

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[1] Professor N. P. Feinsinger comments on the present paper that in some cases—how many we do not know—the parties may have falsified the date of separation in the legal petition, thus making the data statistically unreliable. This is a matter extremely difficult to evaluate. Yet it may be contended that in a large sample of cases here involved occasional falsification could scarcely affect the averages and deviations. There is certainly no evidence of any constant bias in one direction or the other. Moreover, we may hardly assume that falsification is the usual practice whenever petitioners state the time of their separation in their applications for divorce action. See N. P. Feinsinger and Kimball Young, "Recrimination and Related Doctrines in the Wisconsin Law of Divorce as Administered in Dane County," *Wisconsin Law Review*, June 1931, Vol. VI, pp. 195–196, and especially footnote 2.

THE TREND OF INDUSTRIAL DISPUTES, 1922–1930

BY H. M. DOUTY

The purpose of this article is to examine the course of industrial disputes for the nine years 1922–1930, using the period 1916–1921 as a base, and to attempt a brief explanation of the trend. The period 1916–1921 represents a peak in almost every category of strike statistics. Professor Paul H. Douglas, in an admirable article[1] published some years ago, analyzed strike statistics for the forty years 1881–1921,[2] and found (1) that the relative number of strikers in relation to the number of industrial wage earners had increased to a remarkable degree during 1915–1921 over all previous periods, (2) that, for the same period, the number of strikes in relation to industrial wage earners had increased over 1881–1885, 1891–1895, and 1896–1900, but had declined slightly with reference to the years 1886–1890 and more sharply over 1901–1905, and (3) that strikes tended to increase in duration.[3]

The term *industrial disputes* is employed in this article to cover both strikes and lockouts, and, for this reason, the data here presented are not precisely comparable with those utilized by Professor Douglas. This change was made necessary by the fact that, in 1922, the Bureau of Labor Statistics ceased to distinguish between strikes and lockouts.[4] As the two categories of industrial disturbances frequently shade into each other, this departure was not without logic. Lockouts, further, constitute a relatively insignificant proportion of industrial disputes. During the years 1916–1921, for example, lockouts accounted for only 3 per cent of the total number of industrial disputes, and 3.5 per cent of the workers involved.[5]

Statistics of industrial disputes are useful as one gauge of the degree of harmony existing between capital and labor. During periods of wide-spread discontent, open conflicts increase in number and intensity.

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[1] Paul H. Douglas, "An Analysis of Strike Statistics, 1881–1921," this JOURNAL, XVIII, pp. 866–877.

[2] These statistics are contained in the Third, Tenth, Sixteenth, and Twenty-First *Annual Reports of the United States Commissioner of Labor*, the *Monthly Labor Review*, April, 1916, and in the *Monthly Labor Review*, May, 1922. Statistics of industrial disputes were not collected for the years 1906–1913. Those for 1914, and in some respects for 1915, are unsatisfactory.

[3] Professor Douglas' object differed from that of this paper. He sought to test the contentions that strikes were not increasing as rapidly as the industrial population and that stable trade unions tend to minimize strikes. He found that the evidence contradicted both of these assertions. For the subsequent years, 1922–1930, however, strikes and the number of strikers have decreased greatly in terms of the industrial population. The "relative liability" of trade unionists over non-unionists to strike is probably still high.

[4] See *Monthly Labor Review*, June, 1923, pp. 231–232.

[5] *Ibid.*, May, 1922, p. 181.

The period with which we are dealing, however, saw a decisive diminution in the number of disputes and an even sharper drop in the number of persons involved. This latter measure, of course, is the more fundamental. Table I shows the average number of disputes and workers involved, by periods, for the years 1916–1930. The figures are self-revealing. If data on the number of workers involved in all disputes were available, the relative decline would be even more startling.

TABLE I
AVERAGE NUMBER OF DISPUTES AND WORKERS INVOLVED, BY PERIODS *

Period	Average number of disputes per year	Relative number of disputes (1916–1921=100)	Average number of workers involved per year **	Relative number of workers (1916–1921=100)
1916–1921	3,503	100	1,798,809	100
1922–1925	1,304	37	863,051	48
1926–1930 ***	791	23	244,949	13

* Computed from tables in the *Monthly Labor Review*, June, 1931, pp. 23–34.

** Workers involved not reported for 7,179 disputes during 1916–1921, for 1,207 during 1922–1925, and for 252 during 1926–1930.

*** Beginning in 1926, those disputes lasting less than one day and those involving fewer than six persons were excluded. This change in the Bureau's reports probably affects the number of disputes recorded more than it does the number of persons involved.

Table I does not completely indicate the tremendous lessening in both number and extent of the industrial disputes for 1922–1930. The figures can only be made comparable by setting them against the average number of industrial wage earners for the three periods. We shall follow Professor Douglas in using Dr. Hansen's classification,[1] with the calculation of an even numerical increase for the inter-censal years.[2] In Table II, the average number of industrial wage earners for the three periods is given.

TABLE II
AVERAGE NUMBER OF INDUSTRIAL WAGE EARNERS, BY PERIODS

Period	Average number of industrial wage earners (000's omitted)	Relative number of wage earners (1916–1921=100)
1916–1921	17,030	100
1922–1925	18,919	111
1926–1930	20,685	121

The third table gives the average annual rates for the number of disputes and the number of persons involved in relation to the number of industrial wage earners.

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[1] Alvin H. Hansen, "Industrial Classes in the United States in 1920," this JOURNAL, XVIII, pp. 503–506.

[2] Some strikes, a very few, occur among groups outside of the "industrial wage earners" classification. Such, for instance, was the curious strike of about 4,000 artist's models and manikins in Chicago in June, 1928. Professor Hansen would probably rank these among either the "professional class" or the "lower salaried employees."

TABLE III
AVERAGE ANNUAL RATES OF INDUSTRIAL DISPUTES IN RELATION TO THE NUMBER OF INDUSTRIAL WAGE EARNERS, BY PERIODS

Period	Average annual rate per 1,000,000 industrial wage earners		Relative rates (1916–1921 = 100)	
	Disputes	Workers involved	Disputes	Workers involved
1916–1921	206	105,625	100	100
1922–1925	69	45,618	34	43
1926–1930	38	11,841	18	11

These figures tell, with dramatic conciseness, of the diminishing part that industrial disputes played in our economic life as the decade of the twenties advanced. During the years 1916–1921, an average of 105,625 persons annually out of each million of our industrial wage earning population either struck or were locked out; for 1926–1930, this number had been reduced to 11,841. It should be remembered, moreover, that data for the latter period are virtually complete, while for 1916–1921, the number of persons involved was not reported for fully 34 per cent of the disputes. The fall in the number of disputes is almost as astonishing as the drop in the number of persons involved.

We need one more measure to round out the trend. This is given in Table IV, where the average duration of disputes for the three periods is shown. Here again we note a substantial decline.

TABLE IV
AVERAGE DURATION OF DISPUTES, BY PERIODS *

Period	Average duration, in days **	Relative duration (1916–1921 = 100)
1916–1921	29	100
1922–1925	28	96
1926–1930	23	79

* Computed from a table in the *Monthly Labor Review*, June, 1931, p. 31.

** Duration not reported for 11,324 disputes during 1916–1921, for 1,831 during 1922–1925, and for 325 during 1926–1930.

We find, in brief, that the use of the strike and the lockout has rapidly decreased during the nine years 1922–1930 over the period 1916–1921, that the number of persons affected by industrial disputes has shrunk amazingly, and that the duration of disputes has lessened. In relation to the industrial wage earning population, open conflict between capital and labor has probably reached its lowest point in the fifty years for which statistics are available. Considering the crucial aspect of the strike in labor tactics, this situation demands some explanation.

We could, of course, have foreseen a high level of industrial disputes for the years 1916–1921. The period of the War and the post-war boom was favorable to aggressive labor action. The War produced a labor shortage. The sheer necessity of an uninterrupted flow of goods placed labor in a pivotal position. Prices rose with great rapidity, and wages failed to keep step. Hours in many industries were abysmally long at the beginning of the conflict. The worker had many grievances. Organizational work, as a result, went on apace, and in 1920 the trade union movement reached its greatest numerical strength. The full force of the labor offensive was felt in 1919, when more than 4,160,348 workers were involved in industrial disputes. For an obvious strategical reason, there is a tendency for industrial disputes to multiply whenever the industrial situation favors a labor advance.

It is this factor which gives the period with which we are dealing its puzzling character. The depression of 1921 was serious enough, and, in the return to "normalcy," the unions were severely deflated. But the seven years 1923–1929 were blessed with an "unexampled" prosperity. We should have expected, consequently, a fairly high level of industrial disputes, and for two reasons, first, as the result of labor's efforts to regain its losses of the 1921 depression, and, second, as the result of a labor advance. The level, however, constantly fell.

The reasons for this cannot be given with statistical precision. Four developments, though, do suggest at least a partial explanation.

1. The prosperity of the years 1923–1929 was accompanied by a relative stability of the price level.[1] Real wages, moreover, increased appreciably.[2] This was a factor of great importance.[3] Employment in most industries was comparatively steady. The average worker consumed a wider variety of commodities than ever before. Psychological factors, such as the belief in an expanding future, operated to produce industrial peace.

2. The fact that the decade of the twenties saw the emergence of a new and subtle type of industrial relations is significant. The "company union" was almost wholly a post-war development, and by 1926 some 1,400,000 workers were covered by employee representation plans.[4] This weak substitute for genuine trade unionism was the chief issue at the 1926 convention of the American Federation of Labor. There were other forms of the welfare movement. A number of cor-

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[1] *Cf.* Alvin H. Hansen, "Cycles of Strikes," *American Economic Review*, December 1921, pp. 615–621.

[2] Paul H. Douglas, *Real Wages in the U. S., 1890–1926*, pp. 217–389. Paul H. Douglas and Florence Tye Jennison, *The Movement of Money and Real Earnings in the United States, 1926–1928*, p. 27.

[3] About 41 per cent of the disputes between 1922–1930 involved wages. The highly competitive and partially "sick" industries of coal mining, textiles, and clothing had a large proportion of the disputes. The building industry, however, led the field.

[4] Robert W. Dunn, *Company Unions*, p. 8. See also his *Americanization of Labor*.

porations, for example, sold stock to their employees on advantageous terms.[1] Old age pensions were set up. In somewhat humbler form the movement functioned through athletic associations and company magazines.

3. The labor movement itself was not aggressive. Louis Stanley, writing in the New York *Nation*,[2] produced figures to show that the direct organizational work of the A. F. of L. had slowed down. Membership in the A. F. of L. remained practically stationary between 1923 and 1930; if the paper membership of the United Mine Workers is discounted, there was a drop in the number included within the Federation. The unions outside the A. F. of L. no more than held their own. The American movement, by and large, continues to be a movement of skilled craftsmen. The great machine industries have not been organized. The efforts that have been made, as in the case of the automobile workers, were scarcely serious. Douglas wrote that prosperity had robbed the labor movement of its emotional drive.[3] In a sense, indeed, the labor banking movement was symptomatic of an era.[4]

4. Dr. Harry W. Laidler, in a carefully done volume, has shown how highly concentrated our industrial life has become.[5] The concentration movement, expressing itself in a variety of forms, went forward at an accelerated rate during our period. Its effect was to enhance the power of capital, and to make labor activity more difficult.

The four factors outlined above are parts of the complex of our economic life. Taken together, they are suggestive of the forces that have made for the comparative industrial peace of this period. The future course of industrial disputes, now that the golden age has collapsed, should be interesting.

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[1] Robert F. Foerster and Else H. Dietel, *Employe Stock Ownership in the United States.*

[2] Issue of October 8, 1930.

[3] Paul H. Douglas, *Real Wages in the United States, 1890-1926*, pp. 574-575.

[4] Industrial Relations Section, Princeton University, *The Labor Banking Movement in the United States.*

[5] Harry W. Laidler, *Concentration of Control in American Industry.*

NOTES

PROPOSAL OF A COEFFICIENT OF STABILITY

By C. H. Forsyth

The comparatively recent development, the Lexis theory,[1] has not received the recognition in this country which the encomiums of Charlier, Keynes and others should naturally promise. It would seem that the lack of warmth of reception is due in part, at least, possibly to a wide fallacious feeling that that theory is a little too ethereal and may well be more or less ignored in everyday considerations of statistical data; or the lukewarmness may be due to a fear or hesitancy on the part of too many of our statisticians to undertake rigorous determinations and discussions of the basic probability which underlies the given statistical series. In the latter case, the slightly different mode of attack about to be proposed, which calls for no direct reference to probability at all, may be of some value in hastening a long overdue welcome.

Any reasonably rigorous attempt to present the theory is apt to sound rather academic at first because it presupposes that a large group of numerical observations of the happenings and failings of a certain event can be arranged into equi-sized subgroups. However, a little experience with many of our most important sets of data, especially those having to do with the birth or the mortality of human beings, reveals just such classifications in the form in which they are published, except possibly for slight discrepancies in the equality of the sizes of the subgroups. Thus, for example, when we record the number of births or deaths of a community from year to year, or of a number of communities of the same size for the same year, we have at once this classification.

According to the Lexis theory, the computed value of the dispersion of the "happenings" will prove excessive if the basic conditions vary exclusively from group to group, where by "excessive" we mean greater than the value of the dispersion determined by the relation

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[1] W. Lexis, "Uber die Theorie der Stabilitat statistischer Reihen," *Jahrbuch für National Ok. u. Statistik*, Vol. 32 (1879), *Abhandlungen zur theorie der bevolkerungs und moralstatistik*, Kap. V–IX (1903); Arne Fisher, *The Mathematical Theory of Probabilities*, p. 117; H. L. Rietz, *Mathematical Statistics*, p. 146; J. L. Coolidge, *Probability*, p. 70; C. H. Forsyth, "Simple Derivation for the Formulas for the Dispersion of Statistical Series," *American Mathematical Monthly*, Vol. xxxi, 1924.

$$\sigma^2_B = npq$$

where p (readily determined from the given data) is the average rate or probability of the "happening," $q = 1 - p$, and n is the "population" of each group, and where σ_B is the value of the dispersion which we should expect if p (or basic conditions) remained constant at all times. If the computed value of the dispersion proves deficient—which experience shows conclusively to happen only in the most exceptionally reliable statistical data—we are to conclude that whatever variations occur in basic conditions do so only within each group the same for all groups.

We could go much farther in summarizing that fairly well known theory and in describing the three analogous situations or statistical series, termed respectively Lexian, Bernoullian and Poisson, and various ways of differentiating between them but it should be perfectly obvious that what the average statistician is interested in is how to differentiate between only two kinds; the unstable Lexian series and the stable or non-Lexian series. No one appreciates this statement more than he who has been looking zealously, and probably in vain, for a stable series in this country. We go farther and say, for the benefit of those who have given this matter little consideration, that some of our most cherished statistical records, such as annual death rates, birth rates, etc., are indescribably violently Lexian or unstable, and compare in stability in no way with those of some of the older European countries. We have no particular reason for being ashamed of such a comparison, unless we deliberately choose to remain blind to the situation, since we, as a country, are very young and, especially, have an infinitely greater problem (in the size of our country) than our envied European countries have ever faced. On the other hand, the writer feels that we have in the Lexian theory an exceptional and a too little appreciated means of hastening the improvement in accuracy of our most valuable statistical records.

If, as suggested above, we combine the Poisson and Bernoullian statistical series in one class under the heading of non-Lexian or stable series, then for such a series the square of the dispersion, computed directly from the observations, must satisfy the relation

$$\sigma^2 \leqq npq$$

which may be written

$$M^2 \leqq n(M - \sigma^2)$$

where M is the mean of the "happenings" of the various groups. It follows then that for a stable statistical series the ratio σ^2/M must be less than, or at most be equal to, unity. We wish to propose the name "the coefficient of stability C_s" for this ratio, or

$$C_s = \frac{\sigma^2}{M}$$

and suggest that it be used in the analysis of the stability of a given series or set of proper statistical data. In particular, we propose to refer to a statistical series as stable for which $C_s \leq 1$ but we propose to use it also to compare unstable series.

It may be easily shown that the condition placed here upon the value of C_s for stability is *necessary* but not quite *sufficient* to accord with the traditional application of the Lexian theory, since, according to that theory, it develops that we should have $C_s \leq q$ for a Bernoullian or Poisson series, a difference of only $1-q$, or p. The writer questions whether there exists a statistical series, at least in this country, which corresponds to this small interval and even if one could be found, allowances for deviations within the value of the inevitable probable error and considerations of the rarity of series which are satisfactorily stable from either point of view would practically insure the tentative acceptance of the stability of such a series under any circumstances, in exact accord with the scheme proposed here.

A hasty search was made for the most promising statistical series at the immediate command of the writer and the most stable of this list proved to be the list (annual) of stillbirths of the city of Brooklyn and these data for the years 1915–1930 are chosen for illustrating the simple method of applying the proposed coefficient of stability.

Years	Stillbirths	Deviations from mean	Square of deviations
1915	2176	−107	11449
1916	2234	− 49	2401
1917	2233	− 50	2500
1918	2422	139	19321
1919	2246	− 37	1369
1920	2193	− 90	8100
1921	2265	− 18	324
1922	2243	− 40	1600
1923	2258	− 25	625
1924	2462	179	32041
1925	2321	38	1444
1926	2268	− 15	225
1927	2326	43	1849
1928	2435	152	23104
1929	2192	− 91	8281
1930	2254	− 29	841
	16)36625 Mean = 2283	0	16)115474 $\sigma^2 =$ 7217

$$C_s = \frac{7217}{2283} = 3.2-$$

Incidentally, the value of C_s for the annual deaths in the United States from 1915 to 1930 inclusive proves to be almost 24000! Omitting year 1918 with its pandemic of influenza, C_s becomes about 2000, and it would be still less if the slight trend were first removed, but much would remain to be done to make the series anything but a model of instability.

The results for a few statistical series may be of interest and are as follows:

Annual Data

Stillbirths, New York City (5 boroughs) 1915-1930	$C_s = 11.3$
Coal-mine fatalities, United States, 1915-1930	17.4
Deaths, New York State, 1915-1930	
Omitting year 1918	960
Including " "	2000
Births, New York State, 1915-1930	2700
Births, United States, 1915-1929	16000

In all these problems, the original data were first adjusted to a fixed but natural base (population). In several cases, the value of the coefficient would, of course, be reduced somewhat, but without detracting much from the character of instability of the series, if the trend were first removed.

If any reader should happen to become sufficiently interested in the application of the coefficient proposed here to make a fairly extensive search for stable series in this country, the writer would greatly appreciate a report of a successful discovery.

A NOTE ON THE COEFFICIENT OF PART CORRELATION AND OF CORRELATION OF A DEPENDENT VARIABLE WITH ALL BUT ONE OF A GROUP OF OTHER VARIABLES

BY DONALD R. G. COWAN

In his book *Methods of Correlation Analysis*, Dr. M. J. B. Ezekiel describes the characteristics of part correlation and, for obtaining the part correlation coefficient, presents the following formula (p. 182):

$$12^{\bar{r}^2}34 = \frac{b^2{}_{12\cdot 34}\sigma_2{}^2}{b^2{}_{12\cdot 34}\sigma_2{}^2 + \sigma_1{}^2(1-\overline{R}^2{}_{1\cdot 234})}.$$

This formula is based on the derivation presented in the book's Technical Appendix, Note 9, as first worked out by B. B. Smith in collaboration with Dr. Ezekiel and originally published in "Correlation Theory and Method Applied to Agricultural Research."[1]

For those statisticians who use the coefficients of simple correlation in the normal equations and solve directly for β's rather than b's,[2] the above formula may be refined into the following form:

$$12^{\bar{r}^2}34 = \frac{\beta^2{}_{12\cdot 24}}{\beta^2{}_{12\cdot 34} + (1-\overline{R}^2{}_{1\cdot 234})}.$$

This refinement is accomplished by substituting the equivalent $\beta^2{}_{12\cdot 34}\frac{\sigma_1{}^2}{\sigma_2{}^2}$ for $b^2{}_{12\cdot 34}$ and completing the algebraic cancellations.

This formula reveals more clearly that the coefficient of part correlation, $12^{\bar{r}}34$, is merely a correction of the corresponding Beta for the fraction of variability in the dependent factor unexplained by the combined influences of all the factors used, namely $1-\overline{R}^2{}_{1\cdot 234}$. As this residual element is present to the same extent in all of the Betas of a given solution, the coefficient of part correlation has no advantage over the Beta regression coefficient as an indicator of each factor's importance. On the other hand, the Betas of the same factors in two different studies are rendered more comparable by this correction and reduction to the part r form.

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[1] Mimeographed publication, Bureau of Agricultural Economics, U. S. Department of Agriculture, August 1926, pp. 57–60.

[2] As described, for example, in Kelley *Statistical Method*, p. 206, or in Wallace and Snedecor *Correlation and Machine Calculation*.

Having obtained the Betas, it is plain that this formula for 12·34 enables some saving in arithmetic. Since Beta and R or $\overline{R}$ are the only two variables in the formula, it is a simple matter to construct tables from which may be read the values of 12·34 and $12^{2}\cdot34$ (the coefficient of part determination) corresponding to given values of Beta and $\overline{R}$. The accompanying tables serve as illustrations and may easily be extended to give the coefficients of part correlation and part determination for intervening values of β and $\overline{R}$, carried to several places beyond the decimal point.

COEFFICIENTS OF PART DETERMINATION

$\overline{R}=$ $\overline{R}^2=$		.10 .0100	.20 .0400	.30 .0900	.40 .1600	.50 .2500	.60 .3600	.70 .4900	.80 .6400	.90 .8100	1.00 1.0000
β	β^2										
.10	.0100	.0100	.0103	.0109	.0118	.0131	.0154	.0192	.0270	.0500	1.0000
.20	.0400	.0388	.0400	.0421	.0454	.0506	.0588	.0727	.1000	.1739	1.0000
.30	.0900	.0833	.0857	.0900	.0968	.1071	.1233	.1500	.2000	.3214	1.0000
.40	.1600	.1391	.1428	.1495	.1600	.1758	.2000	.2388	.3077	.4571	1.0000
.50	.2500	.2016	.2066	.2155	.2294	.2500	.2809	.3289	.4098	.5682	1.0000
.60	.3600	.2667	.2727	.2835	.3000	.3243	.3600	.4138	.5000	.6545	1.0000
.70	.4900	.3311	.3379	.3500	.3684	.3952	.4336	.4900	.5765	.7206	1.0000
.80	.6400	.3926	.4000	.4129	.4324	.4604	.5000	.5565	.6400	.7711	1.0000
.90	.8100	.4500	.4576	.4709	.4909	.5192	.5586	.6136	.6923	.8100	1.0000
1.00	1.0000	.5025	.5102	.5236	.5434	.5714	.6098	.6622	.7353	.8403	1.0000
1.10	1.2100	.5500	.5576	.5708	.5902	.6173	.6540	.7035	.7707	.8643	1.0000
1.20	1.4400	.5926	.6000	.6128	.6316	.6575	.6923	.7384	.8000	.8834	1.0000
1.30	1.6900	.6306	.6377	.6500	.6679	.6926	.7253	.7682	.8244	.8989	1.0000
1.40	1.9600	.6644	.6712	.6829	.7000	.7232	.7538	.7935	.8448	.9116	1.0000
1.50	2.2500	.6944	.7009	.7120	.7282	.7500	.7785	.8152	.8621	.9221	1.0000
1.60	2.5600	.7211	.7273	.7377	.7529	.7734	.8000	.8339	.8767	.9309	1.0000
1.70	2.8900	.7448	.7506	.7605	.7748	.7940	.8187	.8500	.8892	.9383	1.0000
1.80	3.2400	.7660	.7714	.7807	.7941	.8120	.8350	.8640	.9000	.9446	1.0000
1.90	3.6100	.7848	.7899	.7987	.8112	.8280	.8494	.8762	.9093	.9500	1.0000
2.00	4.0000	.8016	.8064	.8147	.8264	.8421	.8621	.8869	.9174	.9546	1.0000

COEFFICIENTS OF PART CORRELATION

$R=$	.10	.20	.30	.40	.50	.60	.70	.80	.90	1.00
β										
.10	.1000	.1015	.1044	.1086	.1145	.1241	.1386	.1643	.2236	1.0000
.20	.1970	.2000	.2052	.2131	.2249	.2425	.2696	.3162	.4170	1.0000
.30	.2886	.2927	.3000	.3111	.3273	.3511	.3873	.4472	.5669	1.0000
.40	.3720	.3779	.3867	.4000	.4193	.4472	.4887	.5547	.6761	1.0000
.50	.4489	.4545	.4642	.4789	.5000	.5300	.5735	.6401	.7537	1.0000
.60	.5164	.5222	.5325	.5477	.5694	.6000	.6433	.7071	.8090	1.0000
.70	.5754	.5813	.5916	.6069	.6287	.6585	.7000	.7593	.8488	1.0000
.80	.6266	.6324	.6425	.6575	.6785	.7071	.7459	.8000	.8781	1.0000
.90	.6708	.6764	.6862	.7006	.7206	.7474	.7833	.8320	.9000	1.0000
1.00	.7089	.7142	.7236	.7372	.7559	.7809	.8137	.8575	.9166	1.0000
1.10	.7416	.7467	.7555	.7682	.7856	.8087	.8387	.8778	.9296	1.0000
1.20	.7698	.7745	.7828	.7947	.8109	.8320	.8593	.8944	.9399	1.0000
1.30	.7941	.7985	.8062	.8172	.8322	.8516	.8764	.9078	.9479	1.0000
1.40	.8151	.8193	.8264	.8366	.8504	.8682	.8908	.9191	.9548	1.0000
1.50	.8333	.8372	.8438	.8533	.8660	.8823	.9028	.9285	.9602	1.0000
1.60	.8491	.8528	.8588	.8677	.8794	.8944	.9131	.9363	.9648	1.0000
1.70	.8630	.8664	.8720	.8802	.8910	.9048	.9219	.9429	.9687	1.0000
1.80	.8752	.8782	.8835	.8911	.9011	.9137	.9295	.9486	.9719	1.0000
1.90	.8859	.8887	.8937	.9007	.9099	.9216	.9361	.9535	.9746	1.0000
2.00	.8953	.8979	.9026	.9090	.9177	.9285	.9417	.9578	.9770	1.0000

Dr. Ezekiel also presents a formula for measuring "the correlation between one variable and a group of others, after eliminating from the dependent variable that part of its variation imputed (by the analysis) to a single one of the independent variables" (p. 185). This formula is as follows:

$$R^2_{(x_1-b_{12\cdot34}x_2)\cdot x_3x_4}=1-\frac{\sigma_1{}^2(1-R^2{}_{1\cdot234})}{\sigma_1{}^2-2b_{12\cdot34}\left(\frac{\Sigma_{x_1x_2}}{n}\right)+b^2{}_{12\cdot34}\sigma_2{}^2}.$$

As in the case of part correlation, this formula may be shortened for the worker using Betas rather than b's:

$$1-\frac{\sigma_1{}^2(1-R^2{}_{1\cdot234})}{\sigma_1{}^2-2b_{12\cdot34}\left(\frac{\Sigma_{x_1x_2}}{n}\right)+b^2{}_{12\cdot34}\sigma_2{}^2}=1-\frac{\sigma_1{}^2(1-R^2{}_{1\cdot234})}{\sigma_1{}^2-2\beta_{12\cdot34}\frac{\sigma_1}{\sigma_2}\left(\frac{\Sigma_{x_1x_2}}{n}\right)+\beta^2{}_{12\cdot34}\frac{\sigma_1{}^2}{\sigma_2{}^2}\cdot\sigma_2{}^2}.$$

After dividing numerator and denominator by $\sigma_1{}^2$, we obtain:

$$R^2_{(x_1-b_{12\cdot34}x_2)\cdot x_3x_4}=1-\frac{1-R^2{}_{1\cdot234}}{1-2\beta_{12\cdot34}r_{12}+\beta^2{}_{12\cdot34}}.$$

Since $\beta_{12\cdot34}r_{12}$ is a coefficient of partial determination and since $r_{12}=\beta_{12\cdot34}+r_{23}\ \beta_{13\cdot24}+r_{24}\ \beta_{14\cdot23}$ (a normal equation) then $\beta_{12\cdot34}\ r_{12}=\beta^2{}_{12\cdot34}+r_{23}\ \beta_{12\cdot34}\ \beta_{13\cdot24}+r_{24}\ \beta_{12\cdot34}\ \beta_{14\cdot23}$ in which $\beta^2{}_{12\cdot34}$ measures the direct influence of x_2 while $r_{23}\ \beta_{12\cdot34}\ \beta_{13\cdot24}$ and $r_{24}+\beta_{12\cdot34}\ \beta_{14\cdot23}$ measure the joint influence imputed to x_3 and x_4 working through x_2.[1] These quantities are one-half the total joint influence of x_2 and x_3 and of x_2 and x_4. Therefore, by substitution:

$$\begin{aligned}R^2_{(x_1-b_{12\cdot34}x_2)\cdot x_3x_4}&=1-\frac{1-R^2{}_{1\cdot234}}{1-2\beta_{12\cdot34}r_{12}+\beta^2{}_{12\cdot34}}\\&=1-\frac{1-R^2{}_{1\cdot234}}{1-2\beta^2{}_{12\cdot34}-2(r_{23}\beta_{12\cdot34}\beta_{13\cdot24}+r_{24}\beta_{12\cdot34}\beta_{14\cdot23})+\beta^2{}_{12\cdot34}}\\&=1-\frac{1-R^2{}_{1\cdot234}}{1-\beta^2{}_{12\cdot34}-2(r_{23}\beta_{12\cdot34}\beta_{13\cdot24}+r_{24}\beta_{12\cdot34}\beta_{14\cdot23})}.\end{aligned}$$

The meaning of this formula for $R^2_{(x_1-b_{12\cdot34}x_2)\cdot x_3x_4}$ is clear. It is perfect determination (unity) minus the ratio of the fraction of determination unexplained by the group of factors to the fraction unexplained singly and jointly by one of the group. In short, it is a derived coefficient of determination and, as in similar cases, its square root equals the desired coefficient of multiple correlation.

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[1] See *Illinois Agricultural Experiment Station Bulletin 293*, "Adjusting Hog Production to Market Demand," by F. F. Elliott.

INTERPOLATION FOR POPULATIONS WHOSE RATE OF INCREASE IS DECLINING

BY T. J. WOOFTER, JR., *University of North Carolina*

The usual method of interpolation of inter-censal population is to apply either the arithmetic or the geometric average increase to the base year. The latter compounds a fixed rate of increase just as compound interest increases capital at a fixed rate (see Table I).

TABLE I
ARITHMETIC, GEOMETRIC AND REVERSED GEOMETRIC INCREASE OF 100,000 TO 150,000 IN 10 YEARS

Year	Arithmetic	Geometric	Reversed geometric
1920	100,000	100,000	100,000
1921	105,000	104,138	105,960
1922	110,000	108,447	111,681
1923	115,000	112,936	117,180
1924	120,000	117,609	122,458
1925	125,000	122,475	127,525
1926	130,000	127,542	132,391
1927	135,000	132,820	137,064
1928	140,000	138,319	141,553
1929	145,000	144,040	145,862
1930	150,000	150,000	150,000

The procedure of interpolation by the geometric average is correct only if the rate remains the same and the actual annual increment increases. This is not true, however, of many groups whose birth rate falls faster than the death rate, or whose emigration overbalances the natural increase. In these groups the greater numerical increases occur at the beginning of the period instead of the end as in column 4 (reversed geometric) of Table I.

In order to meet this situation a procedure may be adopted which is arbitrary but no more so than the use of the geometric average for steadily compounding populations. The procedure suggested is illustrated in column 4 of Table I. In this column the increments obtained by the geometric average rate as shown in column 3 were reversed, i.e. the 1929–1930 increment was assigned to 1920–1921, the 1928–1929 increment to 1921–1922, etc., until the 1920–1921 increment was assigned to 1929–1930.

The arithmetic involved in this process is long drawn out and is applicable only to interpolation and not to extrapolation. For these reasons the reversed geometric series has been reduced to a parabola which may be derived in two ways:

(1) By actually fitting a curve to column 4 and expressing the constants a, b and c in terms of P_0, the population of the first year in the series, P_1 the population of the last year, r the geometric rate of increase, and n, the number of years in the series.

(2) By deriving the constants of the parabola described by the geometric average increases and substituting for the a constant an a' which is as far above the arithmetic average of the two populations as a is below this average, i.e. $a' = P_0 + P_1 - a$, and changing the sign of c to minus.[1]

By these processes the constants of the reversed parabola plotted from the mid-year origin are:

$$a' = P_1 + P_0 - \text{anti-log}\left[\log P_0 + \frac{\log P_1 - \log P_0}{2}\right]$$

$$b = \frac{P_1 - P_0}{n}$$

$$c = \frac{a' - \dfrac{P_1 + P_0}{2}}{\left(\dfrac{n}{2}\right)^2}$$

and the full equation is:

$$y = P_1 + P_0 - \text{anti-log}\left[\log P_0 + \frac{\log P_1 - \log P_0}{2}\right] + \frac{P_1 - P_0}{n}x - \frac{a' - \dfrac{P_1 + P_0}{2}}{\left(\dfrac{n}{2}\right)^2}x^2$$

i.e., by using the values in Table I, $P_0 = 100{,}000$, $P_1 = 150{,}000$, $n = 10$, and $r = .4138$, the equation becomes:

---

[1] The data for this derivation are:

$\log(1+r) = \left(\frac{\log P_1 - \log P_0}{n}\right)$ (r being the geometric average rate of increase).

$\log P_x = \log P_0 + x \log(1+r)$.

If the parabola is plotted from the mid year as zero x, then $y = a$ at that point, the $\left(\frac{n}{2}\right)^{\text{th}}$ year from the first year in the series.

i.e. $\log a = \log P_0 + \frac{n}{2}\log(1+r)$, or $\log P_0 + \frac{n}{2}\left(\frac{\log P_1 - \log P_0}{n}\right)$, or $\log P_0 + \frac{\log P_1 - \log P_0}{2}$.

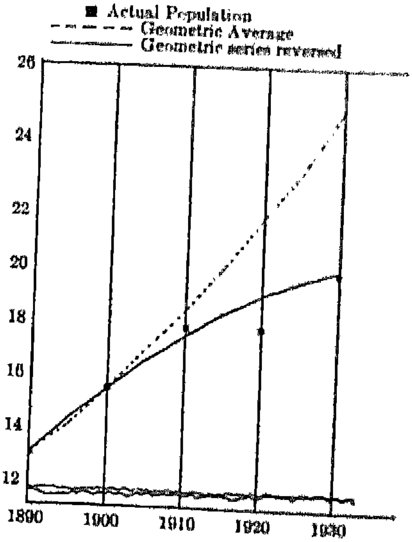
Then $a' = P_0 + P_1 - \text{anti-log}\left[\log P_0 + \frac{\log P_1 - \log P_0}{2}\right]$

$b =$ the arithmetic average increase or $\frac{P_1 - P_0}{n}$. Given a and b, c may be derived as $\frac{P_0 - a + \frac{n}{2}b}{\left(\frac{n}{2}\right)^2}$.

i.e. when $y = P_0$, $x = -\frac{n}{2}$ and $P_0 = a - \frac{n}{2}b + \left(\frac{n}{2}\right)^2 c$.

$$y = 250,000 - 122,475 - 5000x - \frac{127,525 - 125,000}{25}x^2$$
$$= 127,525 - 5000x - 101\ x^2.$$

MISSISSIPPI—TOTAL POPULATION
INTERPOLATION 1890-1900—EXTRAPOLATION 1900-1930
FROM THE BASE 1890-1900



An example illustrating the fact that the reversed series applies to populations with descending rates of increase is afforded by the population of the United States from 1920 to 1930. P. K. Whelpton has worked out the actual annual increases fairly accurately from the data on immigration, births and deaths. His series, as published in the *American Journal of Sociology*, No. 6, Vol. XXXVI, p. 867, corresponds fairly well with the reversed geometric average and departs widely from the geometric average.

If serious errors are made in interpolating with the geometric average, still more serious errors arise from extrapolation, i.e. if we should endeavor to determine the 1933 population of the United States from the geometric average rather than the reversed geometric parabola. Further example of this error is furnished by the population of Mississippi, shown in the accompanying chart. If an attempt were made to extrapolate the 1930 population of this state from the 1890–1900 base, the result by the geometric average would be 2,038,000, by the reverse it would be 2,025,000, and the actual enumeration was 2,010,000.

FURTHER REMARKS ON THE GRAPHIC METHOD OF CORRELATION

I. A REPLY TO "SOME CHARACTERISTICS OF THE GRAPHIC METHOD OF CORRELATION"

BY MORDECAI EZEKIEL

In a featured note in the March, 1932, issue of this JOURNAL, Dr. Warren C. Waite presented certain criticisms of the graphic method of correlation, and reached the conclusion

> 1. That the graphic method of correlation will generally yield different results from the classical method . . . except for the case where the independent variables are uncorrelated.
>
> 2. That the results of the graphic method are not in themselves consistent, but yield different estimated values of x_{1c}, indexes of multiple correlation and slopes of regression lines, if the order in which the independent variables are considered is changed.

Dr. Waite states that these criticisms apply to the "methods of graphic correlation (which) have been presented recently, and (which) have been widely employed, particularly in the study of agricultural prices." He then defines what he understands by the term "the graphic method." The method which he describes was used to some extent about ten years ago, notably in Holbrook Working's original study of potato prices,[1] and gave good service as an early approach to multiple curvilinear correlation. Subsequently, however, as more exact methods were developed, the cruder method described by Waite was discarded, and so far as I know has not been used in any substantial work for several years. The method now generally known as "the graphic method" is that introduced by Bean in 1929. This method is quite different in its procedure from the method which Waite describes, and Waite's criticisms do not apply to Bean's method at all.

Dr. Waite states that the graphic method "starts with a gross regression between two variables." This is not true of Bean's method. That graphic method does not start with a gross regression, but with an approximation to the net regression, determined by examining the position (on the scatter diagram) of observations for which the values of other important variables are constant, or nearly so. This rule is explicitly stated in the article by Bean, in which the method was first

[1] Holbrook Working, "Factors Determining the Price of Potatoes in St. Paul, and Minneapolis," University of Minnesota, Agricultural Experiment Station, Technical Bulletin 10, 1922.

presented,[1] and in the chapter on the graphic method in my text on correlation methods.[2] Thus the article by Bean directs:

> "1. Plot three scatter diagrams . . .
>
> "2. Determine by inspection a first approximation to the net relation between X_1 and X_2" (p. 388);
>
> and, "We make use of the fact that if the relation between X_1 and X_3 and X_1 and X_4 could be held constant simultaneously for a group of two or more observations, the comparable observation in X_1X_2 would lie along a line either linear or curvilinear which would indicate the true regression for X_1X_2" (p. 389).

But even if this rule were not followed, Bean's graphic method would still tend to approximate the true net regressions, since the regressions first determined are not accepted as the net regressions, but only as first approximations to them, to be successively corrected by comparing them with the residuals remaining after the influence of the other variables has been at least roughly eliminated, until a final position is reached where no further shift in any curve is found necessary. The graphic method thus determines the final position of each regression line or curve by a series of approximations, by means of which each net regression line or curve is determined by a convergence process. This point also is specifically covered in the two references given. Thus Bean's article states:

> 5. Plot the residuals from the curve established in 4 as deviations from the other two first approximation curves and make second approximations, where necessary to reduce the residuals still further (p. 388).

Likewise in my text, the same point is emphasized:

> The final fit of the several lines or curves is tested by the same successive approximation process employed in chapters 10 and 14 (p. 229).

Dr. Waite apparently is also not aware of this second characteristic of the method, since he states that the method "successively compares the residuals with the values of *new* variables" (italics mine).

Dr. Waite's supposed mathematical demonstration of the graphic method's weaknesses rests entirely upon these two misconceptions as to how the method now generally recognized actually operates. His demonstration proves, first, that where there is correlation between the independent variables the gross regression coefficient is different from the net regression coefficient. (Every worker in multiple correlation knows that this is true; if it were not, there would be no need for multiple correlation!) It then proves that if the regressions on other factors are determined by eliminating the *gross* regression of the factor first considered, without correction by successive approximations, the results will vary according to which factor is considered first. No one would deny this conclusion for the method stated; but that method is not the recognized graphic method.

---

[1] Louis H. Bean, "A Simplified Method of Graphic Curvilinear Correlation," this JOURNAL, Vol XXIV, pp. 386–397, December, 1929.

[2] *Methods of Correlation Analysis*, Chap. 16, Short-Cut Methods of Determining Net Regression Lines and Curves, pp. 220–241, 1930.

A full algebraical investigation of the adequacy of the graphic method would be very worthwhile, to determine whether the gradual convergence of the regression lines or curves which is actually obtained by the method can be proved, with rigorous exactness, to yield precisely the net regression lines or curves as the final limit. Until such a thorough mathematical analysis is provided, users of the method may continue to rest their case upon the fact that all the arithmetic tests of the method so far have shown that it does yield results which do not differ significantly from those obtained by the more formal and laborious methods. It may be that a rigorous analytical investigation would show that the convergence process of the successive approximations is only of limited accuracy; until such a demonstration is available, however, the weight of arithmetic experience with the method appears to confirm its validity and to justify its continued use.

It may be that other workers share Dr. Waite's misunderstandings as to what the graphic method is, and have been trying to achieve results by using the earlier faulty process which he describes. If so, his note should serve a useful purpose by calling attention to the errors to which such faulty methods would lead. If, in addition, his criticisms will lead him and others to study the basic articles in which the modern graphic method is set forth, and to learn how it really works, that should be of real service in extending still further the application of this time-saving device. The graphic method has eliminated the greater part of the drudgery which used to be associated with multiple correlation computations, and so has freed this keen and searching tool for still wider spheres of usefulness.

II. REJOINDER

By Warren C. Waite

The improvements in the method of graphic correlation have lessened but have not entirely removed the dangers inherent in the procedure. There also remains a considerable probability that investigators do or are led by the nature of their data to begin with a gross regression line.

AN OPEN LETTER

To the Editor of the Journal of the American Statistical Association:

Dear Sir: While I am indebted to Mrs. Orchard for pointing out the underestimation of the value of food exports in the sentence that she quotes from page 42 of my *Food Supply and Raw Materials in Japan*, and would omit the sentence in any revision, I am surprised to find intentions attributed to me which I have never entertained.

> . . . the author has attempted to measure the food supply of Japan in relation to the population problem. For this purpose he has constructed an index of imports of food which he combines with an index of home production of foods and calls "home production plus imports." This combined index is intended to represent the available food supply of Japan.

The index of home production plus imports is an index of home production plus imports: no more and no less. It is not "intended to represent the available food supply. . . ." There is not a phrase anywhere in the book directly or indirectly suggestive of any such intention. This index is a little by-product contained in appendix 5, and nowhere mentioned in the text. Population is not mentioned in this appendix and no population figures or index or curve is shown in comparison with home production plus imports. The only aim of appendix 5 is to show that when an index of imports is combined with a home production index the slackening tendency of the latter since about 1920 disappears, and thus to suggest caution against underrating the importance of the trend of imports.

I have not attempted to construct a consumption index nor an index of "available food supply," which I suppose to mean annual consumption plus carryover. In supposing that I could have constructed such an index by taking home production minus exports plus imports, Mrs. Orchard underrates the difficulties of the problem. To subtract exports from home production would involve the logically indefensible procedure of subtracting re-exports from home production, and the resulting index would have no meaning. If imports were added the result would still not represent "available food supply." The latter would have to comprise home production minus that part of it consumed in non-food uses minus that part exported, plus carryover from the preceding year minus that part of the carryover consumed in non-food uses minus that part exported, plus imports minus re-exports minus that part of imports consumed in non-food uses.

The latter part of Mrs. Orchard's assertion that "There is very little interpretation . . . the author seems to be more concerned with combating the statements of other writers than in analysing his own material . . ." is without foundation. Only one writer is singled out for criticism in the whole book, and that mainly in an appendix. In two appendices dissent is incidentally expressed from certain ideas of popular writers, but no writer is specified. The last chapter has an attack on protectionism in Japan but not on any writer. As regards interpretation my standpoint is set out on pages 9–10 and page 61. A thorough interpretation would have involved discovery and study of all the first hand sources on the economic history of Japan 1894–1927—the work of a lifetime. As yet I do not read the Japanese language rapidly enough to undertake so wide a study. That is no reason why I should not give the statistical side of the picture at once.

E. F. Penrose

Food Research Institute
Stanford University

A CORRECTION

The sentence on lines 31 to 33, page 384 of our article on "Statistical Correlation and the Theory of Cluster Types" in the December, 1931, issue of this Journal now reading: "Here $s_{(12)}$ and $s_{(13)}$ are both close to zero, while $s_{(23)}$ is significantly different from zero," should read "Here σ_1 is close to zero while σ_2 and σ_3 are significantly different from zero."

Ragnar Frisch
Bruce D. Mudgett

AN INTELLIGENCE SERVICE IN THE SOCIAL WELFARE FIELD

On April 1, the New York State Department of Social Welfare, coöperating with a Committee of the Social Science Research Council, United States Children's Bureau, American Statistical Association, and American Association of Public Welfare Officials, will launch a three-year program, which aims to establish a state-wide social intelligence service for rendering more effective the efforts of public and private welfare agencies throughout the state in the war on human misfortune, illness and want.

This project will be conducted by the Department's Bureau of Research, under the direction of Dr. David M. Schneider. It is being undertaken at the request of the Social Statistics Committee of the Social Science Research Council and involves the creation of facilities for currently assembling in the State Department information on all phases of social welfare activity in the state. Systematically compiled and periodically dispatched to the Bureau's Albany headquarters, these data are designed to provide a constant flow of dependable information covering progress and changes in public and private welfare operations.

In summarized and analyzed form, the results will show the taxpayer what use is being made of his contribution to the state's welfare budget, the total volume of such services, and the manner in which public and private agencies are sharing the cost. They will constitute a reference for the guidance and information of the legislature, public welfare administrators, social workers, directors of institutions, contributors to philanthropic enterprises, and others whose interests are in any way connected with social welfare.

The purpose of the Committee of the Social Science Research Council in this enterprise is to provide a demonstration of the best methods of currently providing accurate information on the operation of welfare agencies on a state-wide basis. It is expected that the procedure developed will be adopted in other states. It is, therefore, giving official recognition to the Department's Bureau of

Research as its authorized agency for the three-year demonstration project and has appointed a special advisory committee to represent its interest in the work. The advisory committee consists of Dr. Ralph G. Hurlin of the Russell Sage Foundation, chairman, Frank Bane, American Association of Public Welfare Officials, Sara Kerr, Buffalo Foundation, Katharine F. Lenroot of the United States Children's Bureau, and Dr. Horatio M. Pollock, New York State Department of Mental Hygiene. The State Board of Social Welfare has also appointed a special committee on research consisting of President Victor F. Ridder, Mrs. Mary G. Simkhovitch, Mr. Arthur Lehman, and Mr. Paul S. Livermore, all of whom are members of the Board.

In approaching the New York Department of Social Welfare with its suggestion for this project, the Committee on Social Statistics of the Social Science Research Council took into account not only New York State's key position and importance as the largest state in the union, and its large variety of both public and private social agencies, but also the organization and achievement of the Department of Social Welfare itself, which were believed most favorable for a consistent, diligent prosecution of the three-year plan. The fact that the Department of Social Welfare already had a Bureau of Research in active operation was recognized as a significant indication that the Department could effectively carry out such a program.

The scope of the study will include all the social welfare agencies coming within the purview of the Department of Welfare. Special attention will be directed first to the following fields: child care, including 154 institutions for dependent children, 100 temporary shelters for children, 90 child placing agencies; mothers' assistance, given through 48 boards of child welfare; children's courts; public outdoor relief given in 116 city and county districts; old age relief, 79 separate offices; public homes for the aged of which there are 62 in the state; and hospitals (300).

Other groups of agencies to which attention will be given later include: private homes for the aged, dispensaries, public veterans aid offices, private family welfare agencies, and reformatories and industrial schools.

In carrying out the program the Department of Social Welfare announces that its purpose throughout will be to make the services of its Bureau of Research of as great use as possible to the individual agency in all fields of welfare work. Field service will be provided in so far as possible to advise with and assist city and county public welfare offices and other welfare agencies with their problems of statistical recording and reporting.

FELLOWSHIPS AND GRANTS OF THE SOCIAL SCIENCE RESEARCH COUNCIL, 1932–33

The eighth annual awards of Research Fellowships were announced in March, 1932. From a total of 113 applications, 30 new Fellows were appointed for 1932–33 and one extension of a 1931–32 Fellowship was made. The total amount involved in these awards approximated $86,000. Since the inception of the fellowship program in 1925, a total of 169 persons have been awarded Research Fellowships, with stipends aggregating over $521,000.

As in previous years, the major objective of these Fellowships continues to be the development of more adequately trained research investigators rather than the immediate execution of specific pieces of research. The holders of Fellowships ordinarily have a year (in exceptional instances a somewhat longer period) in this country or abroad entirely free from teaching and other duties, in which to secure further field training or clinical experience, to become acquainted with new points of view, schools of thought, or experimental work, and in many instances to apply the techniques and procedures of related disciplines to their own special fields of activity.

The basic stipend attached to these Fellowships for a period of twelve months is $1,800 for a single, and $2,500 for a married, Fellow, with adjustments upward in case there are dependents. Supplementary allowances are granted to cover travel and incidental expenses as needed.

The Research Fellowships are open to both men and women of American or Canadian nationality provided (1) they are not over thirty-five years of age, and (2) they are the holders of the Ph.D. degree or its equivalent in terms of other types of training and experience. In rare instances, one or more of the formal requirements stated above may be waived.

The third annual awards of Fellowships to Southern Graduate Students in the social sciences were made on March 24, 1932. From 177 applicants, distributed throughout the South, 17 students were appointed Fellows for 1932–33, involving stipends aggregating $10,500. Of the 17 Fellows, 14 are men and 3 women. Five of the group are Negro students.

The objectives of these Fellowships are twofold: (1) to make it possible for an increasing number of promising Southern students to initiate and carry on graduate work in the field of the social sciences, and (2) to provide opportunities whereby some of the future leaders in business, law, and journalism in the South may broaden their understanding of social, economic, and political problems by pursuing graduate study for a year or more prior to entering upon their strictly professional training. In evaluating applicants, special emphasis is placed upon evidence of a genuine interest in, or work already done on, problems of particular significance to the South.

During 1931–32 the Social Science Research Council awarded 40 grants-in-aid out of 104 applications. The total amount involved in these grants is approximately $23,500. Since the inception of its grants-in-aid program in 1927, the Council has allocated over $113,000 to 167 individual research projects ranging over the fields of economics, social, economic and political history, political science, sociology, social psychology, anthropology, law and statistics.

The grants-in-aid are open to mature scholars, without reference to age, whose ability to do productive research is attested by first-class completed work. The project for which aid is sought must be well under way and promise significant results. Ordinarily, the maximum grant does not exceed $1,000. Where-ever possible, institutions to which applicants are attached are expected to contribute financially or with other special support. Grants may be used to defray such items as the investigator's living expenses while in the field, the costs of travel, clerical or statistical assistance.

For the second successive year the Southern Regional Committee of the Council has made available a limited number of small grants-in-aid to members of the social science faculties of Southern colleges and universities. The objectives sought by these grants are (1) to facilitate the completion of significant pieces of social research already under way and (2) to stimulate the development in Southern institutions of more favorable conditions and more liberal facilities for the carrying on of social science research.

Without regard to age or graduate degrees, all social science teachers in Southern colleges and universities whose capacity to do creditable research has been demonstrated are eligible to apply for these grants. In considering applications, special account is taken (1) of the applicant's willingness to forego summer or extension teaching so as to have more free time to devote to his research problem, and (2) the willingness of his institution, if it seems desirable, to lighten his regular teaching load without any reduction in his salary.

Regarding closing dates for applications and other information, address the Social Science Research Council, 230 Park Avenue, New York City.

THE COSTS OF MEDICAL CARE

How can all the people of the United States, rich and poor, obtain adequate, scientific medical service at a cost which can be reasonably met by them in their respective stations in life? This was a question which the Committee on the Costs of Medical Care started out to solve when it organized in May, 1927.

Under the chairmanship of Dr. Ray Lyman Wilbur this Committee has now completed four and one-half years in its five-year study and in November it will issue its final report with recommendations.

Its investigations are conducted by a research staff with headquarters in Washington, under the direction of Dr. Harry H. Moore. Medical associations and other professional organizations have coöperated in the work, while eight of the country's leading foundations have provided the funds.

The Committee has no connection with any agency of the national or any local government; nor has it committed itself in advance to any policy or program except that of dispassionate inquiry.

The studies which it has made, and is making, fall into three main groups:

1. The extent of sickness and disability in the United States and the existing facilities for dealing with them.

2. The amounts that American families pay for medical service and that physicians and other agencies furnishing such services receive.

3. The significance of specific attempts now being made by specially organized agencies to provide medical care to particular groups of the population, including organized medical service in industry, in universities, and in the army; pay clinics and group clinics; hospital service for persons of moderate means; and existing types of health insurance in the United States.

The Committee on the Costs of Medical Care is endeavoring to find a feasible solution to the unhappy paradox of present medical practice. While doctors and dentists are in their offices frequently waiting for, rather than waiting on, patients, there are thousands of individuals who need and want medical or dental care but who have insufficient money to pay for it. The Committee has also found that whereas the per capita cost of illness and of medical care is not great if spread over the whole people, the cost is so unevenly distributed among those who actually buy the service in any one year as to constitute a serious burden on 20 to 30 per cent of them. It is the unevenness of illness and not the average expense that causes the serious problem.

Two specific instances may be selected from many thousands of schedules in which typical American families set down for the Committee on the Costs of Medical Care their medical expense accounts. One family of moderate income got through the entire twelve months covered by the schedule with a total medical bill of $5.02. Another family, with an income of $4,200 a year, ran up a total medical bill of $2,071.15 in a single twelve months' period.

In various communities which have been surveyed by the Committee, the average per capita expenditures annually for medical care are as follows: The State of Vermont, $21; San Joaquin County, California, $36.09; Shelby County, Indiana, $21; Philadelphia, $54.

The reports already published by the Committee are: The Five-Year Program of the Committee on the Costs of Medical Care; The Extent of Illness and of Physical and Mental Defects Prevailing in the United States; a Survey of Statistical Data on Medical Facilities in the United States; Hospital Service for Patients of Moderate Means; Medical Care for 15,000 Workers and Their Families; A Survey of the Medical Facilities of Shelby County, Indiana; Capital Investment in Hospitals; Private Group Clinics; A Survey of the Medical Facilities of the City of Philadelphia; A Study of Physicians and Dentists in Detroit; the "Municipal Doctor" System in Rural Saskatchewan; A Survey of the Medical Facilities of San Joaquin County, California; a Survey of the Medical Facilities of the State of Vermont; The Costs of Medicines; Midwives, Chiropodists, and Optometrists—Their Place in Medical Care; The Healing Cults; and A Survey of the Medical Facilities of Typical Southern Counties.

Others to be published are: Professional Incomes of Medical Practitioners in the United States; The Economics of Some Organized Medical Services; The Fundamentals of Good Medical Care; The Cost of Living in the United States with Special Reference to the Costs of Medical Care; The Costs of Sickness During a Twelve Months' Period Among Various Representative Family Groups; The Economics of Medical Care—A Summary; and The Final Report of the Committee on the Costs of Medical Care.

BIRTH, DEATH AND MARRIAGE RATES OF LARGE GERMAN CITIES IN 1931

Dr. Dornedden, of the *Reichsgesundheitsamt*, Berlin, reports[1] on the birth, death and marriage rates of large German cities in *Reichsgesundheitsblatt* for March 16, 1932. The rates were as follows for the period 1928 to 1931.

LIVE BIRTHS, DEATHS AND MARRIAGES PER 1,000 OF RESIDENT POPULATION, LARGE GERMAN CITIES, 1928 TO 1931

Rate	1931	1930	1929	1928
Live births per 1,000	11.7	13.0	13.3	13.6
Deaths per 1,000	10.3	10.1	11.3	10.8
Marriages per 1,000	8.7	9.8	10.3	10.2

The death rate at the important age periods was reported as follows:

DEATHS PER 1,000 RESIDENT POPULATION, LARGE GERMAN CITIES, 1930 AND 1931

Age period	1931	1930	1931 as per cent of 1930	German Republic, 1928
1 to 4	4.4	5.4	82	5.7
5 to 14	1.5	1.9	79	1.6
15 to 19	1.8	2.0	90	2.4
20 to 39	3.1	3.2	97	3.9
40 to 59	9.2	9.2	100	9.7
60 and over	52.4	48.6	108	54.9

Mortality in these German cities declined during 1931 at all age periods under 40 years, remained stationary between 40 and 59 years and increased 8 per cent beyond 60 years. For the principal diseases the experience since 1928 was as follows:

DEATH RATES PER 10,000 POPULATION PRINCIPAL DISEASES AMONG RESIDENT POPULATION IN LARGE GERMAN CITIES, 1928 TO 1931

Disease or condition	1931	1930	1929	1928
Malignant tumors	14.1	13.8	13.7	13.7
Heart diseases	12.8	13.3	14.5	13.9
Tuberculosis	7.9	8.1	9.1	9.2
Cerebral hemorrhage	8.1	8.0	8.5	8.6
Pneumonia	7.6	7.1	9.7	7.9
Suicide	3.2	3.2	2.9	2.8
Influenza	1.7	0.7	4.3	1.2
Diphtheria	0.7	1.2	1.1	0.8
Measles	0.2	0.2	0.4	0.3
Whooping cough	0.2	0.4	0.4	0.4
Scarlet fever	0.1	0.2	0.2	0.3
Typhoid fever	0.1	0.1	0.1	0.1
Meningitis	0.1	0.1	0.1	0.1

The tuberculosis death rate registered a further decline to a new low figure, 79 per 100,000 of population. Cancer increased during 1931 in the German cities, as it did in most areas in the world for which records are at hand. Influenza and pneumonia recorded slight increases. The suicide death rate in 1931 remained the same as in 1930.

EDWIN W. KOPF

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[1] Bevölkerungsbewegung in den Deutschen Grosstädten im Jahre 1931. *Reichsgesundheitsblatt*, Jahrg. 7, no. 11, March 16, 1932.

WHAT STATISTICS CONTRIBUTE TO PUBLIC HEALTH

A dinner meeting of the American Statistical Association was held on Friday evening, January 29, 1932, at the Hotel Empire, Broadway and 63rd Street, New York City. Alfred J. Lotka, of the Metropolitan Life Insurance Company, presided. The general topic for discussion was "What Statistics Contribute to Public Health."

The first paper, dealing with the subject of "Occupational Mortality Statistics," was read by Miss Mary V. Dempsey of Washington, D. C. Miss Dempsey outlined the need and importance of ascertaining death rates by occupations —rates which have never been available in this country. This need was given impetus by the publication, late in 1927, of the *Occupational Mortality Report* of the Registrar General for England and Wales.

The National Tuberculosis Association appointed a research worker to coöperate with the Census Bureau during 1929 and 1930 in an effort to promote more definite and more complete occupational designations on death certificates, thus facilitating the compilation of such statistics. During this period, the adequacy of occupational returns was tested on 53,342 death certificates; 21 state registrars of vital statistics were visited in their home offices; and an occupational handbook was prepared for the use of undertakers and local registrars. Of this handbook, 49,400 copies have been distributed. Recommendations were made indicating in which states the data were sufficiently accurate to warrant the compilation of death rates by occupation.

Occupational death rates can best be computed in connection with the decennial census of population, since it classifies the occupations of all persons enumerated. Unless such rates are computed for 1930 and 1931, occupational mortality statistics for the United States will not be available for another decade.

The second speaker of the evening, Dr. George T. Palmer, of the American Child Health Association, described the recent work of that organization in evaluating school health programs in terms of health aspects in children. Owing to the difficulty of measuring health as an entity, a principle of indirect evaluation was developed by Dr. Raymond Franzen, Research Director on this special study. The different types of measures, including measures of socio-economic status, were described.

Among the chief points brought out was the major influence of social and economic status in determining the differences between groups of children in various cities of the country. Variations in nutritional status of children are almost entirely accounted for by social and economic factors, which are apparently independent of the influences of the school health program. Visual acuity and the correction of defects by glasses do not differ from place to place and, since social and economic status does differ, it is concluded that visual acuity is not affected by these factors.

The chief effects of school health programs register in the health knowledge and attitudes of children and in the care of the teeth. The study promises valuable contributions in providing new health measuring tools and in differentiating important from unimportant school health procedures. The application of biometric methods, it was stated, was very definitely needed in studying public health work. The field of education has profited greatly from similar work in the last twenty years, and fully as much may be expected when these same methods are applied more extensively in the field of public health.

The general subject of the public health and the depression was discussed by Dr. Louis I. Dublin, of the Metropolitan Life Insurance Company. He pointed out that the year 1931, like the one previous, had been extremely favorable for the public health. There was as yet no evidence in either the sickness rates or the death rates of any untoward influence of the economic situation on the health of the people; and this was equally true at all ages of life and in virtually all sections of the country. The last two years showed minimal death rates in spite of the large volume of unemployment and undoubted economic distress of which everyone is aware.

It was also very gratifying to find that, during this period of emergency, civic agencies, including the medical profession, and public health workers, as well as the social welfare departments, functioned admirably. In no other way could the fact be explained that even the tuberculosis death rate had continued to decline at a rapid rate, namely, about six per cent a year. Infant mortality continued its decline to the lowest figures on record as also did the rates for maternal mortality. No one could say how long such favorable conditions would be reflected in the public health reports. But for the time, at least, there was no cause for public alarm.

Dr. Dublin bewailed the crudeness of the measures which are usually applied to determine the state of the public health but, nevertheless, seemed to be convinced that there was no doubt that people were still well cared for. He ventured the opinion that, if a thoroughgoing analysis were made, it would be found that the favorable health conditions could be traced to the reduced diets and to the greater care which many people were compelled to exercise in budgeting their incomes.

The last participant in the program was Dr. Emma A. Winslow, Research Director of the New Jersey Pension Survey Commission. She described the plan of investigation and findings in a recently completed study of trends in child dependency relief.

During the last ten years the number of dependent children under state supervision in New Jersey increased from 7,920 to 27,275. Public expenditures for their care grew, within this period, from $786,065 to $4,335,458. While the rate of increase has been accelerated during the recent years of economic depression, there was a marked upward trend noticeable in the preceding years of widespread economic prosperity.

As a basis for recommending changes in the laws controlling public relief of child dependency so as to curb certain unnecessary phases of the present upward trend in state care, the Pension Survey Commission has been making a detailed statistical analysis of the reasons back of this increase in cases and expenditures.

Dr. Winslow stressed the importance of carefully planned statistical studies in connection with the preparation of various types of health and welfare legislation, and the necessity of clear, simple presentation of findings if they are to function effectively in arousing interest in the enactment of the recommended plans.

The following resolution was adopted:

> Resolved, that the New York Chapter of the American Statistical Association, at a meeting held January 29, 1932, urges the preparation by the U. S. Bureau of the Census, Vital Statistics Division, of occupational mortality tables in so far as personnel and funds permit.

The meeting adjourned.

May Ayres Burgess

FORECASTS OF COMMODITY PRICES

A dinner meeting of the American Statistical Association was held on Tuesday, February 23, 1932, in the Ball Room of the Hotel Commodore, 42nd Street and Lexington Avenue, New York City. Laurence H. Sloan, Vice-President of the Standard Statistics Company, presided. The meeting, in general, was devoted to "Forecasts of Commodity Prices."

The first speaker of the evening was Mr. K. C. Li, President of the Wah Chang Trading Corporation and Governor of the National Metal Exchange. The subject of his address was "Silver." He began by pointing out that silver was serving as a medium of exchange in China at least five thousand years ago. Curiously enough, the ratio of the value of gold to silver in 700 B.C. in China was sixteen to one—the same ratio advocated by William Jennings Bryan in 1896. Up to 1870, silver was the chief medium of exchange in the markets of the world. Even today, the weight of silver used for money is ten times as great as the weight of gold used for money. England adopted bi-metallism in 1696 and this system remained in force until 1816 when Lord Liverpool's gold standard act was passed.

That bi-metallism tends to steady the relative values of the two metals is shown by the fact that between 1800 and 1872 the price of silver in terms of gold fluctuated only from $1.28 to $1.38 per ounce. After the demonetization of silver by Germany and the United States in 1873, the price of silver fell until, by 1875, it was worth only $0.65 an ounce. Between 1920 and the end of 1931, considerable quantities of demonetized silver were sold by various governments including Indo-China, Siam, Mexico, Great Britain, France and Belgium. These sales had some depressing influence on the silver market but the greatest blow came when the Indian Government began its shift to the gold standard. Actually that government has sold only about 120 million ounces of silver since 1926, but the knowledge that a very much greater quantity might be put on the market has been a large factor in the decline of silver prices to the all-time low of $0.25¾ per ounce in February, 1931.

This demoralization of silver prices has had a disastrous effect upon world trade, for more than one-half of the world's population is on a silver standard or regards silver as an important form of wealth. The purchasing power of these people is greatly reduced by the fall in the price of silver.

During recent years, there has been a scramble for gold, for the production of that metal has not been sufficient to keep pace with world trade. Practically two-thirds of the gold is locked in the vaults of France and the United States. The result is a disastrously low level for commodity prices and depression in business everywhere. To arrest this depression we must reverse its course by restoring values and commodity prices. To accomplish this, more gold must be made available or some other remedy used to correct the situation. Unless new gold mines can be discovered, the only feasible way of accomplishing this end is by using paper money or silver as a substitute for gold in conducting the business of the world. Since the issuance of paper money is likely to lead to trouble, the best plan is to use silver as a treasury reserve against note issues. It would be highly desirable to have an international conference to arrange for the accomplishment of this end.

The speaker closed by stating his views as to the outlook for the price of silver. In his opinion, demonetization is about completed, and sales due thereto can no longer depress the market. He felt that Great Britain's departure from the gold standard late in 1931 would make it unnecessary for the British-Indian Government to sell silver in order to secure funds to maintain the rupee at eighteen pence in gold. Furthermore, the fact that so many countries have gone off the gold standard will probably lead them to use more silver as subsidiary coinage. Finally, the production of silver has been greatly reduced. More than 70 per cent of silver comes as by-products from basic metals. With the production of these basic metals greatly curtailed, it is estimated that the silver production in 1932 will be less than 150 million ounces as against 190 million ounces in 1931.

All of these facts speak well for future improvement in the market.

The second address of the evening was given by Mr. A. W. Zelomek, Economist for the Fairchild Publications and Borsodi Analytical Bureau. The topic with which he dealt was, "The Outlook for Cotton, Wool, and Silk Prices." Mr. Zelomek pointed out that each textile fibre has an influence upon the price of all others. In the United States, the price of cotton is influenced especially by the supply factor. The price of wool, on the other hand, is dependent, primarily, upon demand. In the case of silk, the supply in Japan and the demand in the United States are of approximately equal importance in fixing the price.

Recently, cotton prices have been extremely low, in fact, the October figure, as related to wholesale prices, in general, was at the lowest level on record. This low price was largely the result of the world's supply being the largest ever known. Consumption of cotton has been above normal during the last few months. The average price of cotton this year is slightly below what one might normally expect from the conditions of demand and supply. The price in the future will, of course, be affected by the size of the cotton crop. The outlook for the next crop is influenced by the following facts:

Acreage is likely to be reduced some 10 or 15 per cent. Because of the mild winter, the damage from boll weevil will be above normal. Low prices will mean scanty use of fertilizer. The probabilities are, therefore, that production will be lower in 1932 than in 1931. Even so, however, it is not probable that there will be a shrinkage in the American supply available for use. The demand for cotton goods will probably rise somewhat in the United States and, if world conditions improve, the demand will increase greatly elsewhere. All in all, therefore, cotton prices should rise somewhat during 1932 unless the yield per acre should be unusually large. However, prices above 10 cents per pound are unlikely for some time to come.

In the case of wool the demand in foreign countries affects prices more than the demand in America. Prices in this country are at the lowest levels in a quarter of a century, being, at present, 5 cents per pound below the pre-war average, although we now have a 34 cent duty on scoured wool in contrast to the free entry of wool before the War. Wool consumption has recently been increasing in Great Britain, the United States and Japan. In continental European countries, however, the demand has fallen off somewhat.

For a considerable period of time, the demand for woolen fabrics in the United States has been declining because office buildings, homes, and automobiles have been better heated, and because woolen fabrics have been relatively higher priced than other fabrics. Total stocks of wool at the beginning of 1931 were the lowest in over a decade. The end of 1931 showed slight change in this regard. Partly because of increasing demand from Japan, the probabilities are that wool prices will rise slightly during 1932. One can hardly see, however, how they can gain more than 20 per cent.

The decline in the price of silk has also been very drastic, the present price being not more than one-fourth of that prevailing a few years ago. The existing abnormally low prices have been occasioned largely by a steady upward trend of production, a trend rising slightly faster than the rate of consumption. Although, during the last year, production slackened, the industry is still faced with a record carry-over. Since the depression, the world demand for silk has fallen sharply, the decline in the United States being somewhat less than elsewhere. The demand in this country for women's hosiery has been maintained at a high level. The present outlook for the price of raw silk is less favorable than that for wool, but there is a chance for a moderate advance. Silk fabrics have lost out, to some extent, to wool, cotton, and rayon. Rayon has displaced silk to a marked extent in the manufacture of underwear and ribbon.

The third paper of the evening was read by Mr. Frank D. Ruppert of Case, Pomeroy and Company, but written by Mr. Charles E. Snyder, Editor of the *Corn Belt Farm Dailies*, Chicago. He discussed the live stock industry.

Mr. Snyder pointed out that about 70 per cent of the total acreage of the United States is devoted to raising food for livestock. During 1931, the total value of horses, cattle, sheep, and swine shrank about 28 per cent.

The number of sheep in the country has increased about one-third during the last ten years, showing the tendency of the people of the country to eat more mutton. At present, the number of sheep is the largest on record, hence a period of low prices is to be expected. Existing lamb prices are still relatively higher than cattle prices and much higher than pork prices, even though the slaughter of lambs has continued at an uninterrupted record-breaking rate for several months. However, the per capita consumption has increased from 5.4 pounds in 1928 to over 7 pounds in 1931. Nevertheless, our per capita consumption is still not over a third of that in such countries as England and Australia. The

National Live Stock and Meat Board is financing a campaign for lamb consumption. The probabilities are, however, that. in spite of this campaign, prices will drift lower during the next three months because of the very large number of lambs newly raised to be marketed.

During 1931, the number of cattle in the United States increased about 2½ per cent, the greatest growth being the number of dairy cows which rose 4 per cent during the year. The number of cattle slaughtered in January, 1932, was 12 per cent below the average for the last ten Januaries. The number of cattle on feed at the beginning of 1932 was about 5 per cent smaller than the year before. Beef cycles during the past half century have usually run for a period of 16 years. The present cycle of increasing production is supposed to have gotten under way in 1928 and should reach its peak about 1936. There is nothing in sight to promise higher prices but, at the same time, lower prices are not indicated.

During the year 1931, the hog population of the United States increased about 8 per cent. However, with the exception of the years 1903, 1905, and 1926, the number of hogs on January 1st, 1932, was the smallest of the present century for that time of year. Present low prices of hogs tend to discourage the production of pigs for next spring. The market for pork has, of course, been restricted by small export demand and the limited ability of the people of this country to buy. During the last few months, a relatively small amount of pork has been stored, most of it being thrust on the market. As a result, stocks of pork on hand are abnormally low. When consumption demand is as low as it is, and the weather unfavorable for pork eating, it would be rather foolish to predict any large rise in prices. This could be brought about only by a change in general industrial conditions. In the past, when hog prices have been very low in this country, Europe has come into our market with large orders. The present depression, however, is world-wide and the ability of Europe to buy has been decreasing. Furthermore, pork production across the Atlantic has been large, and higher foreign tariffs have handicapped our export trade. Recently, however, prices in Europe have been so low as to discourage hog production there.

The probabilities are that hog prices will show an upward trend for some little time. Meat is now one of the largest articles on the menu. The consumer cannot stop eating. The result is that, of all industries, the meat industry is operating today at perhaps the fullest capacity. While profits are not general, unemployment is at a minimum. When the price trend starts upward, the benefits of better prices to the live stock farmer will be immediate.

The last of the regular addresses was delivered by Fred Uhlmann, President of the Uhlmann Grain Company, and Vice-President of the Chicago Board of Trade. He spoke on "Wheat and Corn."

He mentioned the wide distribution of wheat production, it being scattered mainly throughout India, Australia, Canada, Russia, and the United States. At normal prices, the corn crop of the United States is worth about double the wheat crop. It is not usually recognized that poultry products sell for more than the wheat total in the United States. The present difficulties in the wheat belt began during the World War when the United States, in an effort to raise enough food for the Allies, guaranteed farmers $2.26 a bushel for their wheat. This price caused an expansion in the wheat acreage. During recent years, we have witnessed an attempt to sustain the price of wheat through Farm Board action. In the years 1921 to 1928, our average carry-over of wheat from year to year was 128 million bushels. It has risen rapidly each year that the Farm Board has been in operation, until, last July, it reached the enormous total of 334 million bushels, and, at the end of this crop year, it will probably be more than 400 million bushels. This quantity is about equal to the total amount of wheat which has been exported from the United States in the combined years 1928, 1929 and 1930.

However, the probabilities are that wheat will not remain at the unremunerative price levels now existing. An increase will come about, as it did in 1897, through reduction in acreages and neglect of land, and through less government interference. The outlook for the coming year is, nevertheless, not very favorable and wheat is not likely to sell at even a moderately high level unless we have crop failures extending over large areas.

The amount of wheat in the larger centers of the United States, called "Visible Supply" is now about 203 million bushels. This supply sometimes falls as low as one million bushels. While we shall export this year only about 15 per cent of all the wheat shipped from the various large surplus countries, our own carry-over will be about 200 per cent as large as the combined carry-overs of all the other large exporting countries.

The corn outlook is much more hopeful. The price of corn is low at the present time, more on account of the present economic depression than because of overproduction. Notwithstanding the 1931 crop was only about 83 per cent of normal, the price at present is so low that consumption will be very large in the near future. This year, owing to the very mild winter, consumption has been below normal.

Mr. W. W. Cumberland of Wellington and Company, led the discussion on the papers on live stock and silver. He questioned Mr. Snyder's suggestion that live stock trends are a good business index. He also was skeptical that any live stock cycle existed.

He said that, from a statistical point of view, Mr. Snyder's methods were poor. This, he said, was not meant to question the conclusions in themselves. The concept of normal as something that has been, was denied. All other factors such as credit, employment, etc., must be correlated.

In starting the discussion on silver, he expressed a strong belief that silver's importance has been much exaggerated and cited as evidence that American production last year was only about 60 million dollars. The assumption that "something should be done" about silver was likewise questioned. There seemed to him to be no more reason, if as much, why "something should be done" about silver than about any other commodity.

He doubted very much whether foreign trade would be greatly helped by a rise in silver prices. He pointed out that trade with silver countries had held up better than that with gold countries in the past year or two. Furthermore, improvement in silver prices might well hit silver using countries as they are silver importers. A rise in silver would be an appreciation in their monetary unit which would be just as deflationary and therefore depressing to their business as is an appreciation in gold in gold-using countries.

He suggested that, if something need be done about silver, it would be better to make the suggestion to industry than to ask the government for monetary remedial measures. The industrial demand, he thought, might be increased, but he doubted, and expressed no confidence, in government action.

Dr. Lewis Haney, of New York University, discussed the papers on wheat, corn, and the textile fibres. In opening his remarks, he noted that, in his work, credit and currency questions were an outstanding problem in all forecasts of prices and criticized each of the speakers for having ignored so important a subject. His thesis through his discussion seemed to be that prices of commodities are very apt to decline further unless inflation is successful and he put himself on record as an arch enemy of inflationary measures.

He believes that the gold standard is in some danger and that depreciation of currency is in sight. However, powerful factors oppose the success of inflationary measures. Among these is the difficulty of raising domestic prices which are set by world conditions. He noted the fact that prices already have been held up artificially, and cited the huge carry-over of many commodities. The bullish factors in the wheat market were cited as being Europe's need, which must be met in part from North American wheat, and the reduction of the North American crops. However, he noted that Canada, rather than the United States, might supply this need. Against these bullish factors, he placed the American surplus, the ample world output, the lack of signs of change and the fact that American wheat prices are above the world market.

He opposed all of Mr. Zelomek's conclusions and questioned his methods as applied to cotton, to wool, and to silk. He concluded that the cotton outlook was unfavorable and doubted any gain in cotton consumption. On wool, he believed that the domestic market is weak, and that imports would check any rise. He cited the impossibility of forecasting silk prices, but doubted any considerable rise in this field.

A question from the floor addressed to Mr. Uhlmann was "What should be done with governmental wheat stocks?" Mr. Uhlmann replied that the government should sell, that they will be forced to do so at some time, and that these stocks should be put out of the way promptly.

Dr. Haney was asked if he believed a financial collapse was inevitable. He replied that it was not necessarily inevitable and that business could come out of the depression if left alone. He admitted, however, that he found it increasingly difficult to see a way out without a financial collapse in view of all the tampering that is being done.

He called the deflationist the optimist, and the inflationist the most rank pessimist.

Mr. Uhlmann was questioned as to his views on short selling. He replied that, if the bills now in Congress were to pass, or any of them to pass, restricting or prohibiting short selling, that wheat would go so low that no one ever would want to sell it short.

One of those present at the dinner arose to defend the Glass-Steagall bill, and felt that Dr. Haney took much too severe a view of it and the operations which would result from it.

The meeting adjourned.

Donald B. Woodward

PROGRESS OF WORK IN THE CENSUS BUREAU

THE FIFTEENTH CENSUS PUBLICATIONS

Work on the Fifteenth Decennial Census is mainly in the final stage—that of preparing the manuscript for the final reports. Each day brings its shipment of copy to the Public Printer. Owing to the congestion of work in the Government Printing Office proof is not coming back as rapidly as copy goes over, but the Census Bureau cannot be held responsible for that situation. There is a limited amount of machine tabulation still in progress consisting mostly of runs of occupation or family data. These runs will doubtless be completed before July 1.

Meantime the readers of this Journal, it may be assumed, will be interested in knowing what the plan of the publication of the Fifteenth Census comprises. The following list of final reports and bulletin series covers substantially everything that will be published other than special studies or monographs, the number and scope of which will depend on conditions that are uncertain at the present time.

Final Reports.—The following list of the volumes planned for the final reports of the Fifteenth Census is complete, except that as indicated there may be two or three additional volumes in the census of distribution, which are not definitely provided for as yet:

FINAL REPORTS

All volumes except those indicated below as octavo will be of quarto size.

Population	*Number of pages (actual or estimated)*
Vol. I, Number and Distribution of Inhabitants (Octavo; ready)	1,268
Vol. II, General Report—Statistics by Subjects	1,600
Vol. III, Reports by States—Composition and Characteristics of the Population for Counties, Cities, and Townships	
Part I, Alabama-Montana (Ready)	1,395
Part II, Nebraska-Wyoming (Ready)	1,389
Vol. IV, Occupations—Reports by States	1,200
Vol. V, Occupations—General Report	1,200
Vol. VI, Families	1,600
Metropolitan Districts (Ready)	253
Unemployment	
Vol. I, Unemployment—Returns by Classes (Octavo; ready)	1,112
Vol. II, Unemployment—General Report (Octavo)	1,104

Agriculture	*Number of pages (actual or estimated)*
Vol. I, Farms by Minor Civil Divisions (Ready)	710
Vol. II, Reports by States—Statistics for Counties	
Part 1, Northern States	1,392
Part 2, Southern States	1,616
Part 3, Western States (Ready)	592
Vol. III, Type of Farm—Reports by States with Statistics for Counties	
Part 1, Northern States	1,082
Part 2, Southern States	1,140
Part 3, Western States	438
Vol. IV, General Report—Statistics by Subjects	985
Horticulture	132
Irrigation	400
Drainage	484
Manufactures	
Vol. I, General Report—Statistics by Subjects	352
Vol. II, Reports by Industries	1,848
Vol. III, Reports by States—Statistics for Industrial Areas, Counties, and Cities	1,136
Mines and Quarries	400
Distribution	
Vol. I, Retail—Reports by States—Statistics for Counties and Cities (Will probably be published in two or more parts)	4,000
Vol. II, Wholesale—Reports by States—Statistics for Counties and Cities (May be published in two parts)	1,000
Vol. III, Construction—Reports by States—Statistics for Counties and Cities	1,050
Hotels (Octavo; ready)	107

The plan of publication includes also a series of trade reports which may later be assembled to form one or more volumes of the final reports.

Abstract of the Fifteenth Census (Octavo)	1,100

Counting the parts of a volume separately published as separate volumes it will be found that the above list provides for about 30 volumes. It is expected that nearly all the copy for these volumes will have been forwarded to the printer before July 1.

State or Industry Bulletins.—Most of the material contained in the final reports is first published in series of state or industry bulletins. The following is a list of the series of bulletins which are first published separately by states or by industries and later assembled and reprinted in the final volumes:

	Volume in which assembled	
Population:		
First Series—Number and Distribution of Inhabitants (State series, completed)	Population	Vol. I
Second Series—Composition and Characteristics of the Population (State series, completed)	"	Vol. III
[illegible] (State series, completed)	"	Vol. IV
Families (Being issued)	"	Vol. VI
Unemployment: Returns by Classes (State series, completed)	Unemployment	Vol. I

	Volume in which assembled	
Agriculture:		
Statistics by Minor Civil Divisions—Number of Farms, Farm Acreage, and Farm Values (State series, completed)	Agriculture	Vol. I
Statistics by Counties		
First Series—Farms, Acreage, Values and Crops (State series, completed)	"	Vol. II
Second Series—Selected Crops and Livestock, Mortgages, etc. (State series, completed)	"	Vol. II
Third Series—Type of Farm (State series, being issued)	"	Vol. III
Irrigation of Agricultural Lands—Statistics for State and Counties (State series, completed)	Irrigation volume	
Drainage of Agricultural Lands—Statistics for State and Counties (State series, completed)	Drainage volume	
Manufactures:		
1929—Industry Series (State series, completed)	Manufactures	Vol. II
State Series (State series, being issued)	"	Vol. III
Census of Mines and Quarries: 1929—Industry Series (State series, completed)	Volume on Mines and Quarries	
Distribution:		
Retail Distribution (State Series, being issued)	Distribution	Vol. I
Wholesale Distribution (State Series)—Statistics for the State and Cities of 5,000 Population and Over (Being issued)	"	Vol. II
Construction Industry: 1929 (State Series)—Statistics for State, Counties, and Principal cities (Being issued)	"	Vol. III
Merchandising or Trade (In preparation).		

United States Summaries.—Each of the volumes presenting reports by states, namely Population Volumes I, III, and IV, Agriculture Volumes II and III, Manufactures Volume III, and Distribution Volumes I, II, and III, will contain a summary for the United States, constituting the first chapter or section of the volume and presenting the statistics by states and for principal cities. These summaries will also be printed as separates. They will contain no statistics for counties or for the smaller cities and townships other than the total population as given in the first summary listed below, but statistics for states and larger cities will be presented in considerable detail on the subject to which they relate.

The following United States summaries are now ready:

Population:
- United States Summary—
  - Total Population for States and Counties, for Urban and Rural Areas, and for Incorporated Places of 1,000 and over. Octavo, 87 pages.
  - Composition and Characteristics of the Population. Quarto, 79 pages.
  - Unemployment. Octavo, 84 pages.

Agriculture:
- United States Summary—
  - General Statistics. Quarto, 117 pages.
  - Irrigation. Quarto, 22 pages.

Subject Chapters.—The series of volumes in each main division of the census regularly include one volume, designated as the general report, in which the statistics are assembled and presented by subjects. In other words the primary subdivisions of the volume will be by subjects, instead of by states, there being one section or chapter on each subject, such as a chapter or section on age in the Population report, one on farm tenure in the Agriculture report, and one on power used in the Manufactures report. Most of these chapters will be printed as separates.

J. A. H.

MISCELLANEOUS NOTES

Our President's Plans for the Association.—Following the vote of the various Associations meeting together next December, it has been decided by the Directors of the American Statistical Association to hold its annual meeting in Cincinnati between December 29 and 31, 1932. The other Associations which, presumably, will meet at that time in Cincinnati are:

American Sociological Society,
American Economic Association,
American Association of University Instructors in Accounting,
American Association for Labor Legislation,
American Farm Economic Association,
American Land Economic Association,
National Association of Teachers of Marketing and Advertising,
The Econometric Society.

The Committee on Programs and the President would appreciate suggestions for subjects and speakers for our sessions. Among the subjects which have been suggested are the following:

Methodology,
The Depression,
Gold,
Wages and Standards of Living,
Business Profits,
Economic Theory in the Light of Statistical Analysis of Business Phenomena,
Problems Met by Teachers of Statistics and by Company Courses in Statistical Methodology,
Public-Finance Statistics,
Method of Congressional Apportionment,
Hospital Statistics,
Vital Statistics.

I have had the pleasure of meeting with and speaking before two of our Chapters, the Chicago Chapter on January 27 and the Cleveland Chapter on April 8. Both meetings were very well attended, perhaps largely because of the popularity of my topic "The Depression"!

IRVING FISHER,
President of the American Statistical Association

Committee on Governmental Labor Statistics.—The Committee has completed its report on Public Employment Office Statistics in Europe and America, and the manuscript has been submitted to the Russell Sage Foundation for editing and publication. The report will be published as a companion volume to *Employment Statistics for the*

United States, edited for the Committee by Hurlin and Berridge and published in 1926. The public employment office experiments at Rochester, Minneapolis and Philadelphia plan to test the Committee's recommendations in their offices. The next step will probably be the preparation of a manual on statistical procedure for public employment offices.

The Committee held its annual meeting in Washington on December 29, with 20 members, graduate members and guests in attendance. The discussion covered a wide range of labor statistics, but the principal emphasis was given to wages, employee hours, estimates of unemployment and correction of employment indexes. With regard to wages data, the Committee voted to continue its sub-committee on wages, and it is planned to extend the work of the sub-committee considerably during 1932. An effort will be made during the year to clarify further the problems connected with the collection of employee-hours data, and consideration will also be given to provision for adjustment between census and state employment index materials and to standard procedure for eliminating statistical bias.

Association Luncheon Meetings in New York City.—The Association is sponsoring two series of luncheon meetings in New York City, one in the financial and one in the midtown district.

Mr. J. Herbert Leighton has been appointed Assistant Secretary to take charge of the meetings in the financial district. The following persons have been selected as a Planning Committee to aid Mr. Leighton in arranging programs for these meetings:

Dean Langmuir
Irene E. Sheehan
Woodlief Thomas
Robert B. Warren

The first session was held on May 4th. Mr. Ralph West Robey, Financial Editor of the New York Evening Post, initiated the discussion of "The New Federal Reserve Policy: Its Probable Effects, With Particular Reference to the Security Markets."

The midtown luncheon meetings are under the general direction of Mr. Stanley B. Hunt as Assistant Secretary—the other members of the Planning Committee consisting of the following persons:

Leon Henderson, *Chairman*
Alfred T. Falk
Murray W. Kline
Leonard Kuvin
Helen Slade
Felix E. Wormser

The first meeting of this section occurred on May 18th, and the discussion was initiated by Dr. Max Winkler. The topic under consideration was: "What Will Happen to the Foreign Debt Situation After July 1st?"

The Albany Chapter.—A dinner meeting was held on March 1, 1932 at 6:00 P.M. Two papers were given, one by Dr. Horatio M. Pollock of the New York State Department of Mental Hygiene—topic "A New Classification of Diseases"; and the other by Miss Elizabeth Parkhurst of the New York State Department of Health—topic "Growth of Population as Determined by Specific Birth and Death Rates." There were 25 persons attending the meeting.

The Chicago Chapter.—The Chicago Chapter was very fortunate in having Dr. Irving Fisher, President of our Association, address it at a luncheon meeting on January 27. Dr. Fisher brought out a record attendance—135. His subject was "Hindrances to Prosperity." According to Dr. Fisher, the major cause of this depression and of most major depressions has been a state of over-indebtedness. Assuming such a state, the first attempt to overcome it is to sell, which act brings about a falling of prices. Distress selling is next compelled, in order to improve cash position, and the general price level becomes further reduced. Next follows a contraction of currency through liquidation at the banks. Another result of deflation in prices is a fall in the net worth of industrial concerns; the profit-taker then lowers production and discharges employees. We have consequent unemployment and a decline in trade. The psychological consequence thereof is discontent; people become panicky and withdraw their deposits from the bank in order to hoard them, with resultant slowing-up of circulation and a contraction of currency. There is also the effect on the rate of interest, Dr. Fisher pointing out that the real rate of interest may be high even when money rates are low. Therefore, debts, contraction of the circulating medium, reduction in net worth, profit-taking, the human mood, employment, and the rate of interest—all are affected by a fall in the price level. Such a fall, though a natural, is not an inevitable consequence of depression, because it can be compensated for, which it has been in normal times. The Federal Reserve System could do it, by going into the open market and buying bonds, thus creating a circulating medium to maintain the price level. The Federal Reserve did the opposite in 1929, and also failed to raise the rediscount rates at the proper time, but had there been a stabilization program, Dr. Fisher believes that much of the present distress could have been avoided. He claims that the very liquidation which has reduced the price level is no liquidation at all, just because of that. In other words, the fall in the price level has caused a magnification of the value of the dollar. A debt is not a number of dollars but real wealth, and if dollars are weighed as wealth, our present debts are much greater, despite the apparent liquidation that has taken place. The worst of the situation is that the magnification of the dollar, which defeats the effort to liquidate debts, is due to the very effort to pay them—this is the mystery of the depression. However, if we could counteract further deflation in prices, it still is not too late. Dr. Fisher, therefore, believes there is nothing so needful at the present as a mild inflation—just enough to offset present deflation.

On February 25, Mr. George O. Fairweather, of the Governor's Joint Tax Commission, talked before a dinner meeting of this Chapter on the present complicated and unfortunate tax situation in Chicago. His explanations and recommendations were highly instructing and interesting to those in attendance.

There were four speakers for the dinner meeting on March 31, when about seventy members attended. Professor John H. Cover, of Chicago University, discussed "Prospects for Consumption and Retail Trade"; Professor Samuel H. Nerlove, also of Chicago University, explained current trends in corporate income and profits and their relation to the trend in general business and prices; the topic of the talk by Mr. S. W. Russell, of Swift and Company, was "The Outlook for Farm Income"; and Mr. Harland H. Allen, Consulting Economist, discussed "Prices and Purchasing Power." Owing to the prominence of the several speakers in their various fields of study and endeavor, the talks were enthusiastically received and some interesting discussions were provoked between the speakers themselves and also among the members

The Los Angeles Chapter.—The March meeting was held on March 4; the following officers were elected and installed.

President, W. F. French; Vice-President, Keith Powlison; Secretary, J. L. Niceley; Treasurer, M. E. McClendenin; Counselors, J. V. Carson, O. F. Lighthill; and Editor, George J. Eberle.

These officers were duly installed.

Dr. Gordon W. Watkins, Professor of Economics, of the University of California in Los Angeles, the speaker of the evening, outlined the prevailing conditions in our economic structure, his ideas of what measures should be taken by the proper authorities to lift the country from the depression and the trend that events would actually take. This was followed by discussion among the various members along the lines of the seminar.

The Federal Statistics Board.—A Federal Statistics Board has been established for the purpose of assisting the Chief Coordinator of the Bureau of the Budget in coordinating the statistical work of the various organizations of the Federal Government. Circular 293 of the Bureau of the Budget, which created the Federal Statistics Board, said in part as follows:

> It shall be the duty of the Federal Statistics Board to study the existing situation with regard to the collection, compilation, dissemination, and utilization of statistics by agencies of the Federal Government, and to make recommendations to the Chief Coordinator looking to the elimination of needless duplication in statistical work and the fullest possible utilization of statistical information collected and the personnel and facilities connected therewith, as well as the most effective and economical means of procuring additional statistics for which there may be a reasonable demand.

The Board is made up of representatives from the Departments of Agriculture, Commerce, Labor, and the Treasury, the Interstate Commerce Commission, the Federal Trade Commission, the Federal Farm Board, the Tariff Commission, the Bureau of Efficiency, the Civil Service Commission, and the Veterans' Administration. The Bureau of the Budget desires that information regarding the Federal Statistics Board be given publicity, so that persons having statistical problems falling within the scope of the Board's activities may present them for the consideration of its members.

United States Bureau of Labor Statistics.—Reports on technological changes and their effects upon employment in telegraph offices and in the motor-vehicle industry, and on displacement of labor by installation of automatic grade-crossing devices, have been presented in recent issues of the *Monthly Labor Review*. A field study is now under way for road building, and a more detailed study than the one previously made is being conducted for the automobile industry.

The regular study of accidents in manufacturing industries, covering 1930, has been completed and a preliminary report published in the *Labor Review*. Data for 1931 are now being gathered.

An investigation is being made of wages and hours of labor in air transportation. This is the first survey made by the Bureau for this industry. Other studies of wages and hours are in progress for the following industries: Tanning; manufacture of cotton goods, woolen goods, and hosiery and underwear; and dyeing and finishing of textiles. Field work on the surveys of automobile repair shops and filling stations and the slaughtering and meat-packing industry has been completed and the data are being tabulated. Recent issues of the *Labor Review* have carried summarizations of the data obtained by the Bureau on wages and hours in anthracite mining, furniture manufacturing, and bakeries.

Detailed reports on wages in a number of foreign countries, furnished by representatives of the Department of State, have been published in recent issues of the *Review*.

The index of manufacturing employment has been revised to include 89 industries as compared with the 54 previously covered.

A dictionary of occupational terms is being compiled by the Bureau for all of the industries with which it has contact.

United States Children's Bureau.—A recent development of significance in the Bureau is the transfer to its auspices of the current monthly relief statistics collected during 1929, 1930, and 1931 by the Department of Statistics of the Russell Sage Foundation. The transfer of the Foundation's relief data, covering 76 cities of over 100,000 population, was effective as of January, 1932. As a result of amalgamating these statistics with data gathered by the Children's Bureau for the use of the President's Organization on Unemployment, information is now available under centralized direction for 130 cities having more than 50,000 population.

It is the Bureau's plan to publish a monthly bulletin, similar in content and form to the bulletins prepared by the Foundation during the past three years, which will give prompt and concise information on the relief situation throughout the country. The Bureau will also issue a quarterly publication containing more complete and adequate data than are available at the time the monthly bulletins are released. In addition to statistics on the number of families aided and the amount of relief given, the series developed by the Russell Sage Foundation, statistics on two new series—the number of meals served and the number of night's lodgings provided to homeless and transient persons—will be presented in both the monthly and quarterly publications.

In order that the Children's Bureau, in developing this new project, might benefit from the experience of the Russell Sage Foundation, Dr. Ralph G. Hurlin, Director of the Foundation's Department of Statistics, has been retained as consultant in social statistics and Anne E. Geddes, also of that Department, has become a member of the Children's Bureau staff for a period of six months to organize the study.

Reports of the Women's Bureau.—Two studies of women in clerical employment have been published recently by the Women's Bureau. The first, a report on the earnings and trends of employment of the office workers in the state of Ohio, is based on returns made by employers to the Division of Labor Statistics over a period of 16 years. It was written by Amy G. Maher, director of the Information Bureau on Women's Work, at Toledo.

The second report on women in clerical employment is a brief summary of data secured from the employment records of firms in Philadelphia that employ large numbers of women clerks. It is part of an extensive survey of office work being made by the Bureau because of the growing importance of clerical work in general and clerical work for women in particular.

Activities of the Bureau of Agricultural Economics.—In response to a request made by the canners of vegetables, the Bureau is now conducting a research study which has for its goal an analysis of the demand for these vegetables, the effect of the competition of increasing quantities of out-of-season fresh vegetables, and the adjustments which canners and growers of canning crops should make in their acreages. The relation of these various factors to prices of canned vegetables is also being taken into account.

The Agricultural Outlook for 1932 was released in March, 1932, as United States Department of Agriculture Miscellaneous Publication No. 144. On March 26, 1932, appeared a mimeographed "Supplement to the Agricultural Outlook for 1932 Considered in Relation to Farmers' Intentions to Plant in 1932."

Work of the New Jersey Pension Commission.—The New Jersey Pension Survey Commission, established by the legislature of that state in 1930, has recently completed a series of five reports dealing with the various fields of investigation which were assigned. The first of these reports dealt with the general problem of dependency and laid the foundation for the system of old age relief which will go into operation in New Jersey in July of this year. The second report contained detailed statistics on all public expenditures for dependency throughout the state, analyzed by types and by individual municipalities and counties, and also the findings of the Commission as to the inadequacy of present procedures in county and municipal administration of public relief.

The third report, issued in January of this year, relates to the subject of pension systems for public employees in New Jersey and contains a detailed analysis of pension and other benefits under the 152 jointly contributory pension funds now in existence, covering municipal, county and state employees.

For each of these funds, the report shows the present accrued liabilities and the amounts which must hereafter be met out of taxation if present deficits are to be made up and the existing funds continued without substantial reduction of the benefit provisions. According to this report, only two of these funds—those for teachers and for state employees—have been based on sound principles of finance, and the remaining funds are accumulating liabilities at the rate of several millions of dollars per year for which no current provision is being made.

The fourth report, dealing also with the pension systems for public employees, presents the conclusions of the Commission as to the essentials of a soundly financed pension system and the type and scope of benefit provisions which can be justified from the viewpoint both of the public employees themselves and of the taxpayers upon whom the major responsibility of meeting the costs of these systems inevitably rests. Cost comparisons as between existing plans and the proposed system are made in considerable detail, and the report concludes with a presentation and discussion of the specific legislation which the Commission deems desirable for enactment into law during the current year.

The fifth and concluding report of the Commission has to do with the state care of dependent children. Detailed statistics reflecting the rapid growth in the number of child dependency cases in New Jersey during the past decade and the expenditures therefor are presented, as are also the Commission's recommendations for legislative changes in the present child dependency laws.

The research investigations of the Commission have been carried on for the past two years under the direction of Dr. Emma A. Winslow. Mr. George B. Buck of New York City has served the Commission as consulting actuary in connection with its analysis and recommendations as to employee pension systems of the state.

The Pennsylvania Department of Labor and Industry.—The Bureau of Statistics of this Department has asked the Committee on Governmental Labor Statistics of the American Statistical Association to recommend a broader program of statistics for the department. The development of the statistical program for the next few years will be guided by the recommendations made by this committee.

The distribution of a $10,000,000 fund of relief moneys appropriated by the legislature to the county poor districts is being made on the basis of unemployment estimates made by this department.

The Social Science Research Council's Committee on Social Statistics.—The Committee on Social Statistics of the Social Science Research Council has added to its membership Dr. Dorothy Swaine Thomas, of Yale University. Other members are Drs. Robert E. Chaddock (Chairman), Stuart A. Rice (Secretary), O. E. Baker, Nova R. Deardorff, C. Luther Fry, Ralph G. Hurlin, Frank A. Ross and Leon E. Truesdell.

Tenth Annual Meeting of the Milbank Memorial Fund.—The economic aspects of public health and medical services was one of the subjects discussed at the tenth annual meeting of the Advisory Council of the Milbank Memorial Fund on March 17, which was held at the New York Academy of Medicine. Dr. R. M. Atwater, Commissioner of Health for Cattaraugus County, where the Fund has conducted an experiment in establishing a well-rounded public health department, opened the discussion of this subject by presenting a problem of prenatal, maternity and infancy care in a rural community where some 25 per cent of the families are unable to purchase these services at the prevailing prices, and raised the question as to what policy should be pursued in rural communities. That is, should further burdens be placed upon the community in the form of taxation in order that the physicians be adequately paid for their services, or should efforts to place agriculture on a sounder basis be coordinated with efforts to maintain and improve the health and economic efficiency of the population? Professor C.-E. A. Winslow, of Yale University, summarized the operations of the national Committee on the Costs of Medical Care of which the Milbank Fund has been a chief supporter during the past four years. Dr. Louis I. Dublin, third Vice-President of the Metropolitan Life Insurance Company, made an address on the interrelation of economic and public health programs. At the annual dinner, Mr. Albert G. Milbank, President of the Fund, spoke on the need for financial and industrial leaders to follow the example of public health leaders in developing a policy of prevention of depression, and the principal address at the dinner was made by Dr. Ray Lyman Wilbur, Secretary of the Interior, who spoke on the economic problems involved in a better distribution of medical and preventive services. The general meetings of the Council were presided over by Dr. William H. Welch, who at this time retired from the chairmanship of the Council after ten years incumbency. President Livingston Farrand of Cornell University was chosen as his successor.

A conference on the objectives and technique of studies of population problems was held in connection with this annual meeting. Professor Robert E. Chaddock, of Columbia University, presided at the conference which was attended by about fifteen persons interested in various phases of the subject, including Professor W. F. Ogburn, Professor Lowell J. Reed, Dr. Carl G. Hartman, Dr. Warren F. Thompson, Professor Frank A. Ross, President Livingston Farrand and others. A report was made by Professor Raymond Pearl on an inquiry which he is conducting in collaboration with the Milbank Memorial Fund and to the extent to which birth control practices have been employed in samples of child-bearing women. There were also reports on reproductive histories, differential fertility by social class, and modes of research into the factors affecting human fertility.

The National Distribution Council.—Meetings of the Council were held on February 19 and March 18. On the former occasion Dr. W. H. Young, Economic Analyst of the United States Bureau of Mines, gave an address on "Distribution of Coal." He presented tentative data from a comparative study, conducted under the joint auspices of the Brookings Institution and the United States Bureau of Mines, designed to explore the problem of coal distribution and to develop methods of measuring the origin and destination of shipments of coal and coke.

On the latter date, Dr. Nathanael H. Engle, Expert in Marketing of the Bureau of the Census, addressed the Council on "The Marketing of Radio Sets, Tubes and Parts." After tracing the development of the use of radio he discussed the manufacturers' wholesale outlets, the wholesale channels of distribution and the significance of wholesale merchants. He further presented data on operating costs by size of business and discussed retail distribution.

Standardization of Disease Nomenclature.—The standard nomenclature of disease upon which the National Conference has been at work for more than two years, has now been completed and it was unanimously approved at the last annual meeting of the Conference, which was attended by our delegate, Mr. George H. Van Buren. Mr. Van Buren not only acted as adviser in the statistical problems connected with the preparation of the nomenclature, but he has also served, and continues to serve, on the Executive Committee. A tentative printing is about to be issued in order to secure a preliminary trial by a group of large and small hospitals before the publication of the official authorized edition.

The trial period will provide the various national societies with an opportunity to study their respective portions of the work and to adopt it as their official nomenclature. The American Heart Association has already taken this action and no delay is anticipated with other specialist societies because in each instance the work was carried out in intimate coöperation with the respective committee. During the trial period, the National Conference on Nomenclature of Disease, 2 East 103 Street, New York City, expects to receive questions and criticisms and to advise institutions and individuals throughout the country concerning the introduction of the nomenclature.

The University of Pennsylvania Industrial Research Department.—In April, the Department, in coöperation with the Bureau of Compulsory Education of the Philadelphia Board of Education, commenced its fourth annual survey of conditions of unemployment in Philadelphia. This year the scope of questions asked has been considerably enlarged, to the end that there may be obtained a more satisfactory answer than is at present possible to the following questions:

1. What has been the cost of the depression and its consequent unemployment as reflected in family distress?
2. What has enabled Philadelphia families to "pull through" the depression this far?
3. How inadequate have been past and present methods of dealing with unemployment and family distress?
4. How much longer can Philadelphia families get along with existing methods of relief?
5. What additional relief measures are necessary and what form should they take?

The survey is under the direction of Mr. Emmett H. Welch, Research Associate.

Interesting studies have been and are being conducted under the Hosiery, Wool, Savings, Foundry and other sections.

The Institute of Economics.—The Institute of Economics of the Brookings Institution has received from the Maurice and Laura Falk Foundation a special grant of funds to be used in conducting a statistical and theoretical analysis of the distribution of wealth and income in relation to economic progress.

PERSONAL NOTES

Mr. Alfred W. Flux, Assistant Secretary of the Statistical Department of the British Board of Trade, who is at present Chairman of the Committee of Statistical Experts appointed to carry out the recommendations of the International Convention of Geneva (1928) relating to Economic Statistics, will lecture in this country from the middle of October to the middle of December. He will speak on the present currency problems, both national and international. His subjects include: The Gold Standard and Its Breakdown; The Prospects for Sterling; Currency Policy and Trade Depression; Can the International Gold Standard Be Made To Work; and Banking Policy in Relation to Prices and Exchange.

Dr. Charles B. Davenport, director of the Station for Experimental Evolution of the Carnegie Institution of Washington, has been elected a member of the German Academy of Sciences at Halle.

Dr. W. A. Shewhart, of Bell Telephone Laboratories, who has charge of fundamental studies in quality engineering, sailed on April 9 for a two-months' trip to Europe. His first engagement will be the delivery of three lectures at the University of London on the rôle of statistical method in industrial standardization. A number of conferences with Dr. Shewhart have been arranged by leaders in theoretical and applied statistics, both in Great Britain and on the Continent. Dr. Shewhart has recently been elected a Fellow of the Royal Statistical Society of England.

Dr. R. von Huhn has been elected a Fellow of the American Association for the Advancement of Science.

Miss Barbara J. Betz, assistant in the Department of Biology of the School of Hygiene and Public Health of the Johns Hopkins University, has been awarded a grant-in-aid by the International Union for the Scientific Investigation of Population Problems in connection with her study of constitutional types in relation to fertility.

ADDITIONAL COMMITTEE APPOINTMENTS

Joint Committee for the Improvement of Statistics published by the Income Tax Division of the United States Treasury Department

William L. Crum, *Chairman*
Simon Kuznets
Willford I. King

MEMBERS ADDED SINCE MARCH, 1932

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Williams, Robert T., Department of Commerce, Washington, D. C.
Young, Dr. John Parke, Chairman, Department of Economics, Occidental College, Los Angeles, Calif.
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REVIEWS

Economic Control of Quality of Manufactured Product, by W. A. Shewhart. New York: D. Van Nostrand Company. 1931. 501 pp.

Statistical methods in the hands of engineers, as elsewhere, have lately been finding many new uses, as indicated for example by the recent works of Grant and Kurtz. A fresh field of application of these methods is in the control of quality of manufactured articles, where the problem is one of minimizing the costs of inspection and rejections, while maintaining quality at a satisfactory and not too expensive standard. Dr. Shewhart here presents a considerable array of methods, developed in the course of his work in the Bell Telephone Laboratories, adapted to these problems. Their presentation has passed through the stages of lectures for the out-of-hour courses at those laboratories and at the Stevens Institute of Technology, and of partial publication in mimeographed form for limited groups of readers.

Graphic devices play a prominent part in these methods of quality control, and the text is enlivened by a large number of well-drawn figures. One typical form of control chart represents the mean or other characteristic of a lot as a point, the horizontal coördinate being the time or order of production. Parallel horizontal lines define a band within which all the points should fall, and indicate that a special investigation of manufacturing conditions is called for when a point falls outside. The width of the band is a fixed multiple of the standard deviation, which is computed from theory where possible, and otherwise from variations within the lots. The same chart facilitates the graphic detection of progressive tendencies.

The author's main reliance, however, is upon analytical mathematical methods. He quotes with approval the statement of Whittaker and Robinson that in their laboratory, after careful trial, graphical methods had almost all been abandoned in favor of arithmetical procedures.

Dr. Shewhart is one of the few writers on statistical subjects who are sufficiently acquainted with the revolutionary developments of the theory in the past two decades to make effective use of the new discoveries. His discussion of efficiency and sufficiency in estimation is probably the only one since R. A. Fisher's. The graphic representation on page 282 of the decline of efficiency of the median and mid-range with increasing size of sample is an interesting contribution. The graphs on pages 218 and 219 relating to the sampling errors of the correlation coefficient are of much value.

Readers of Keynes' *Treatise on Probability* will recall that the one statistical procedure there given positive approval was the subdivision of data into groups by means of definite criteria and the inquiry as to whether there is excessive scatter among these groups. How to determine whether in a given case the scatter is excessive is a practical problem which had been solved after a fashion by Lexis and Charlier. A more elegant solution is R. A. Fisher's method of analysis of variance, which includes as a special case the use of χ^2 for contingency tables. Dr. Shewhart makes use of the device of division into subgroups. But instead of Fisher's use of the *ratio* of the interclass to the intraclass estimate of variance, he uses the *difference* of these estimates, which must be divided by its estimated standard error to give a pure number having an approximately normal distribution for large samples. Fisher's method is more accurate, at least for samples from normally distributed populations; Shewhart's avoids the use of tables, and is slightly simpler in calculation. For samples from non-normal populations our theoretical knowledge is still lamentably slight.

This inadequacy of theory in the field of non-normal distributions has had to be supplemented for practical purposes by experiments of the urn-stirring type. The author of this book and Mr. F. W. Winters have managed some extensive sampling experiments of which they gave a brief report in this JOURNAL for June, 1928. The book amplifies the account of the experiments and presents the numerical results in detail. These tables should prove very suggestive for future theoretical work in mathematical statistics. Like Tippett's table of random numbers, they may be used to check hypotheses concerning distributions before strict mathematical proofs can be found. They consist of the records of 4,000 drawings each from a normal, a right triangular, and a rectangular population, with the mean, standard deviation, and ratio of mean to standard deviation for each sample consisting of four successive drawings.

One method described for detecting variations of quality with the passage of time is to take the means of successive groups of four. Parallel lines are drawn above and below the level of the general mean, at distances one and one-half times the general standard deviation from it. This distance corresponds to three times the standard deviation which the means of four would have if the observations were independent. If there is a positive correlation between successive cases, the tendency will be for the points representing the means of groups to fall outside the lines more frequently than in the absence of correlation. This method of detecting changes with time may be compared with such procedures as correlating successive observations directly, or the calculation of the coefficients of trend with their standard errors. It is obvious that the grouping test may be varied by changing the numbers in the groups or the multiple of the standard deviation to be used. In choosing four as the number in a group, convenience in calculation plays a part.

The author considers variation not only of the means of the subgroups, but also of the standard deviations, and of other statistics. He presents a considerable variety of criteria for the control of quality, including correlation with extraneous variables suspected of being causes of variation, and fitting with a two-term Gram-Charlier frequency curve, with an excessive value of χ^2 taken as an indication of the need of looking for trouble.

Extensive use is made of the Camp-Meidell and Tchebycheff inequalities. In view of a remark on page 245 it should be added that the Tchebycheff inequality need not be confined in application to limits symmetrically placed about the mean. If m is the square root of the second moment about any value whatever, the probability of differing from this value by more than km is less than k^{-2}.

On page 184 the statement is made that although we have the distribution function for standard deviations of samples drawn from a normal universe, we do not have a table of the integral of this function. The standard deviation of the standard deviation is therefore used. But the exact probabilities associated with the distribution may be obtained at once from the tables of the χ^2 integral upon putting

$$\chi^2 = \frac{\Sigma(x-\bar{x})^2}{\sigma^2} = \frac{ns^2}{\sigma^2},$$

the denominator being the population variance and the numerator being calculated from the sample. If one desires the maximum and minimum values of σ corresponding, say, to a probability .01 of excess in each direction, they may be obtained by finding the values of χ^2 corresponding to $P=.01$ and $P=.99$, with a number of degrees of freedom less by unity than the number of observations, and then using the equation above.

There are a few minor slips which can easily be corrected. A graph on page 76 seems to be in error, since a distribution for which $\beta_2=1$ must consist of only two values with equal probabilities. The skewness and kurtosis should not be stated in inches as on page 85, since they are pure numbers. The ellipse on page 295 should for strict rigor be replaced by a flattened oval, as in the work of Neyman and Pearson in *Biometrika* for 1928, to take account of the non-normal distribution of the standard deviation. In connection with page 135 it may be noted that the normal law was found by De Moivre as early as 1733.

The book should interest many statisticians, in addition to the production engineers who will be primarily concerned with it. Some elementary statistics and calculus are required in reading it. Its statistical theory is on a highly commendable level.

HAROLD HOTELLING

Columbia University

Les Principes de la Méthode Statistique, by Lucien March. Paris: Félix Alcan. 1930. xi, 807 pp.

The purpose of this massive book by the well-known professor of the *Institute de Statistique* of the University of Paris, and the honorary director of the *Statistique Générale* of France can best be given in his own words of the preface (freely translated):

> In the present work . . . it is proposed to give an exposition of the most common and most useful research methods of present-day statistical methodology, without exaggerating their value and without requiring an act of faith in propositions not demonstrated or at least not explained. It is always dangerous to apply formulas of which one has not grasped the underlying meaning and spirit. . . .
>
> This work is divided into three parts. In the first we stress the essential conditions of accurate observations and proper classification of numerical facts, and the attention which should be given first of all to the qualities and properties of the observed facts, in the order in which they appear.
>
> The second part is devoted to a detailed exposition of the principles of the mathematical treatment of the collected data, without particular regard to the

extent of the field of observation. Some numerical examples on selected data aid in grasping the technique.

In the third part, the principles of statistical analysis are applied to data in the fields of both the natural sciences and economic movements, especially business movements.

The author believes

> there may be some advantage in simplifying the outline of the method, so as to render it as little abstract as possible, and to introduce only those simple arithmetical operations which do not require special mathematical preparation.

We further note with commendation the author's prefatory remark,

> However, the language of mathematics, if it is useful because of its precision, also has its dangers. One abuses it when one uses it to say what ordinary language expresses as clearly and more simply, and especially when one loses sight of the hypotheses on which the calculations rest, or when one ignores the necessity of showing that these hypotheses agree with reality.

The first section of seven chapters deals with Observation and Classification (200 pages). It gives valuable detailed consideration to many of the elementary essentials of the preliminary gathering and organization of data. Much of the material might be described as organized common sense, but as common sense based on wide experience. After the introduction, which deals with the general aspects of the statistical method and related disciplines, are treated such topics as observation, notation, statistical units, measures, variations, schedules and forms, control and selection of observations, summarization of data, tabulation, and classification.

In the second part of eleven chapters (300 pages) Statistical Analysis or theory is approached from a strictly mathematical standpoint and in elaborate detail. The exposition is largely by theorem, corollary, and "remark," with innumerable formulas and elaborate nomenclature. The presentation moves from "simple comparisons" to "complex comparisons," which include treatment of periodic and logarithmic as well as algebraic functions. Groups of items are then considered, chapters being devoted to averages, variability, variability of sub-groups (in much detail), association of series, series of alternatives. (These last three chapters are reproduced from *Metron* for June, 1926.) Chapters on "particular distributions," graphic representation, and adjustment, interpolation and extrapolation complete this section on statistical theory. A notable lack is the entire absence of any treatment of the normal curve of error: perhaps the author considered this beyond the scope of the elementary mathematics he assumed as the equipment of the student.

The third section of ten chapters (294 pages) on Applications repeats much of the second part, covering much of the analysis as applied to special types of data. Chapters are devoted to size distributions and averages, sampling, correlation and contingence, index numbers, applications to the natural sciences (paragraphs being devoted to meteorology, bacteriology, biometry, actuarial science and psychology), applications to business, net-cost studies, balance-sheet study, and forecasting.

In the judgment of the reviewer, the contribution of March in the present work lies in the first two parts, and especially the first part, of careful analysis of fundamental details. There is little new either in material or presentation in the rest of the book, aside from the fact that it is gathered in one volume—which is, of course, a service. Especially after the introductory remarks above quoted regarding the examination of underlying hypotheses, we felt a distinct lack of a critical attitude, not only in the theoretical material, but in the practical application chapters. There is treatment of probable error formulas, etc., of course, but this is a formal treatment; the student is not constantly warned of the limitations of the method and tools described, and the liability of misuse. For instance, in showing the use of the coefficient of correlation between two time series to determine the typical lag, two examples are cited where the maximum values of the coefficients are .236 and .341, with no suggestion of a warning that these coefficients have little if any significance.

We are in doubt as to the exact group for which the book is intended; most of the material is too elementary for the experienced or advanced student, while much is too brief and concise for mastery by a beginner. Very slight use is made of charts and graphic illustration of the material (there are only 50 charts in the 800 pages, and these are largely concentrated in a few spots). The chapter on graphic representation is quite mediocre and inadequate. There exist (in English, at any rate) many presentations of correlation which any statistician could name, which are much more lucid and meaningful than that of March. The applications to the natural sciences and to economics are entirely inadequate: but what can be done in 35 pages in presenting the whole field of time series analysis, seasonal variation, cycles of varying length (with no treatment whatever of secular trends) and forecasting—all in a single chapter entitled Forecasting? Even in the "practical" chapter on averages, the approach concerns their mathematical properties, with no consideration given to the problem of judging which is more representative of a distribution for various purposes.

Coming to just a few details of interest, first we note an unfamiliar average described. March, in addition to the usual averages, defines the *médiale* (p. 267) as the size of the item in an array which is at the mid-point in the cumulative sum of the items. Just as the *médiane* (median) is the stature of the center man in a company of infantry when standing side by side in order of height, the *médiale* is the stature of the man in the center when the men are lined up lying on the ground head-to-foot. Without denying that there might be some significance to this value in some conceivable case, its uses are not evident, and are not discussed at all in the text. The *intermédiante*, defined as the *médiale* minus the *médiane*, is described (p. 292) as a measure of dispersion, but its relation to or advantages over other commoner measures of dispersion are not discussed. At another place (pp. 519, 524) the *intermédiante* is referred to, we believe erroneously, as a measure of symmetry.

March assigns two distinct meanings (pp. 527–532) to the term "arithmetic" mean, first the ordinary sense, and second the idea of an abstract or theoretical mean in contrast with a "statistical" or concrete or practical mean.

In dealing with the correlation of time series in economics, March distinguishes between the correlation of deviations from the means (*l'indice de covariation différentielle*) and the correlation of first differences (*l'indice de covariation* *tendancielle*) but he does not mention the equally important correlation of deviations from trends.

Finally we would question the distinction between an *indice budgétaire* and an *indice monétaire* which March had previously expounded in his *Movement des prix et des salaries pendant la Guerre*. The former is the ordinary weighted aggregative to show, for instance, changes in the cost of living. For the second, the *indice monétaire*, March follows Edgeworth, Bowley, et al., in considering an index of the value of money as representing the *uniform influence of monetary causes*, as distinct from the divergent multiplicity of causes affecting the prices of individual commodities. Observed prices, by this view, are a mixture of these two elements, the common effect of monetary causes, influenced and masked by the distorting individual demand and supply changes. Prices are thus regarded as numerous independent *observations* of a single phenomenon, the effect of monetary causes. By direct analogy to the physical sciences (an analogy specifically cited by March, as well as by Edgeworth and others) the "monetary index" is thus a concrete average, representing a real existing phenomenon, rather than simply a convenient representative value, and the theory of errors is applicable. Whereas Edgeworth advocated the use of the median, March recommends the (arithmetic or geometric) mean, *unweighted* except as weights representing the exactitude of observation might be applied. No method is suggested, however, for determining such weights.

This is not the place for a detailed argument, but we believe this view of price or purchasing-power index numbers is fallacious. Aside from the fact that this view rests on the disputed quantity theory of money, we believe the analogy to physical measurements or observations is entirely fallacious. The simplest economic theory of the interaction of all price changes disposes of the view that the prices of numerous articles are independent observations. The concept itself of the uniform effect of monetary causes ignores all contractual relations and varying elasticities of demand.

These criticisms of the third part especially should not be construed as a blanket criticism of the whole book. March has performed a service in his painstaking first part on preliminaries, and his comprehensive treatment of elementary statistical theory.

The absence of an index is a serious deficiency of the book, from the standpoint of a reviewer, as well as that of the student or research worker.

Wirth F. Ferger

University of North Carolina

Medical Impairment Study: Report of the Joint Committee on Mortality of the Association of Life Insurance Medical Directors and the Actuarial Society of America. New York. 1931. 172 pp.

This book is a study of the effect of certain medical impairments on the mortality of insured lives covering the same general impairments that were investigated in the *Medico Actuarial Mortality Investigation*, published in 1912–1914, although the subdivisions are in some cases different and several new classes have been added. That investigation covered the standard issues of 1885 to 1908, inclusive; this covers the standard and substandard issues of 1909 to 1927, inclusive, carried to the anniversary in 1928.

The data were contributed by 39 companies having in force four-fifths of the total life insurance in the United States and Canada, and include 1,100,000 entrants, with 41,000 deaths, about one-third of the material being classed as substandard. Standard and substandard cases were kept separate in the investigation.

A Basic Mortality Table of standard lives for the same period (1909–1927) was prepared as a measure of the expected deaths. The function graduated was the ratio of the actual mortality to that by the American Men Select Table. The aggregate of death claims for this Basic Table was 78 per cent of the A. M. Select, and ratios by ages and durations were in general from 70 to 90 per cent of that table. Certain peculiarities in the mortality made the formation of an accurate ultimate table practically impossible. Deaths in the Basic Table were used to form tables of "Death by Cause," both as a percentage of total deaths and in the form of death rates per thousand exposed, for comparison with causes of death in the impairments investigated.

For nearly all classes, the average of company ratings was determined for the total standard and substandard business combined.

The experience under each class is listed and compared to the expected number of deaths according to the Basic Table and, as a guide in determining the significance of the data, an approximation to the probable deviation of the mortality ratios was given, based on the following formula:

$\pm 1/\sqrt{\theta'} \times MR$ where θ' is the actual number of death claims, and MR is the mortality ratio.

Following the description of methods employed, the book gives the results in each class in considerable detail, comparing these results with the average of company ratings and the results of the M. A. M. I. when the classes are comparable. When the actual and expected deaths differ considerably, the comments of the committee are interesting and in several classes further analysis was made in order to interpret the results correctly. Of particular interest were those classes where a higher mortality was experienced in the standard than in the substandard section, and the classes dealing with heart murmurs and blood pressures, which seem to indicate an increasing mortality among such insured lives.

Several combinations of impairments were studied confirming previous impressions. A new combination, albumen in the urine and overweight, was of special interest and indicated a much greater mortality because of combination than had been previously supposed.

The "Detail Tables" following the description and comment on the various classes permit further study as to the effect of age and duration on mortality.

The committee also points out that certain of these impairments will show a higher mortality by amount than by policies (the basis of this investigation) especially in connection with overweights and heart impairments, and that individual company selection may have been satisfactory in a group that has been generally underrated by all the companies combined.

Certain results of a study of build that was being made contemporaneously have also been included in this volume. Except at ages under 20, there was little variation from the M. A. M. I. tables and only for these younger ages have new tables been published. The present study, with its larger volume of data, shows that the irregularities smoothed out by graduation in the previous investigation were not accidental fluctuations, but characteristic features, making these new build tables advisable.

This is the latest of a series of such studies made by the same combined organizations and each mark an advance in the application of statistical analysis to insurance selection. It must always be remembered, however, that since the data have been furnished by companies whose practices affecting selection vary widely, the results of the investigation must be subjected to critical interpretation and adaptation for use by individual life insurance companies.

CECIL F. CROSS

Lincoln National Life Insurance Company

The Mathematical Part of Elementary Statistics, A Textbook for College Students, by Burton Howard Camp. D. & C. Heath and Company. 1931. 409 pp.

The teaching of statistical method in economics, sociology, business or education is too often superimposed upon anything but a sound mathematical foundation. The student who enters upon his graduate work adequately prepared mathematically to cope with the statistical methods needed in his field, is indeed an exception. Usually teachers of statistics in graduate schools find that they must go back and build up the most elementary mathematical concepts for their students. The old adage "A little learning is a dangerous thing" is nowhere so true as in statistics. Misuses of method and misinterpretation of statistical results inevitably follow a superficial knowledge of the mathematical foundations of statistical technique.

To correct this situation Professor Camp has prepared a most interesting and inclusive text for a course to be given to students in the sophomore year. This course covers the essential mathematical concepts back of most statistical methods. Students grounded in the work covered in this text should be well prepared to undertake the applied courses in statistics and to interpret their results without fear of overlooking assumptions implied in the mathematics of the method that were not valid in the actual data.

The text is conveniently divided into two parts. Part One is intended to provide a sufficient background for most applied courses. An elaborate table of contents replete with formulae inadequately replaces an index. Many exercises and examples are given. Data drawn from current business sources lend an air of practicality to various problems.

This is, however, definitely a textbook for a course in mathematics and bears all the earmarks of authorship by a mathematician. It is to be hoped that some day a *statistician* who knows as much about mathematics as does Professor Camp, will undertake this task, not for students of mathematics, but for students of statistics.

D. H. DAVENPORT

Harvard University

Monetary Problems of the British Empire, by S. E. Harris. New York: The Macmillan Company. 1931. 569 pp.

This valuable treatise is the culmination of a period of intensive research by the author extending from 1926 to the present. However, his interest in the subject dates from 1920–1921 when he wrote a paper on the British Currency Notes for Professor Kemmerer's Seminar at Princeton. The book is a noteworthy achievement for many reasons, although in some aspects it is regrettably inadequate.

As the author says in the Preface, "The study of British Monetary Policy should not be confined to an examination of the monetary condition in Great Britain alone. Isolation in monetary policy is a phenomenon of the past." For this reason the book covers not only an analysis of the monetary problems of Great Britain, but also of the Dominions and India. In broad outline, the book covers the period of the World War and post-war inflation, followed by the period of deflation and including in its scope an analysis in rich detail of the mechanism of the money market so far as it was affected by government war and post-war finance. This interpretation necessarily led the author into an endeavor to link the monetary problems of Great Britain with monetary conditions in other countries and especially the United States. At strategic points in the progress of his analysis, he has inserted "appendices" and "notes" describing in detail facts and controversial issues directly bearing upon the monetary problems discussed; but which, if included in the text proper, would constitute extended digressions. Also, at appropriate points he has introduced brief summaries which tend to give cohesion to the analysis otherwise highly complex and somewhat disjointed. The book is painstakingly documented and constitutes a scholarly treatment of the subject not only for this reason, but because the author has at numerous points in his analysis given critical summaries of the pertinent views of various authorities. It is thus not merely a statistical summary of what has occurred, but that combined with a thoroughgoing investigation into what has been considered to be the explanation of these phenomena by others, how they agree or disagree, and finally the author's own interpretation. Sixty pages of classified bibliography with the author's brief description and evaluation of every important reference is an important part of the contribution made by this book.

The nature of the analysis may be obtained by the following few examples, taken more or less at random:

> An examination of the Bank of England figures reveals that the very large rediscounts of pre-moratorium bills and advances to acceptors were not of as great significance as might be expected; the explanation is that the discounts and advances were *successive*.
>
> . . . . .
>
> . . . Ways and Means financing was not as important a cause of inflation as has generally been assumed. Special Deposits were a mechanism for depriving

> the market of surplus balances, and hence were in a sense deflationary. Similarly, Department Ways and Means were deflationary, because as departmental advances were made, transfers were made from the money market to the Government. This statement holds for the advances from the Currency Notes Account.
>
> . . . . .
>
> When the Treasury was unable to obtain adequate supplies of cash by the sales of Treasury bills and the acceptance of Special Deposits at rates determined by the Government, it borrowed from the Bank directly. Thus the Treasury prevented rates from rising further. The Treasury rate was both a minimum and a maximum. The Bank rate was therefore of limited significance in the years 1915 to 1921 except in so far as it reflected the Treasury rates.
>
> . . . . .
>
> The problem of inflation is in large part a problem of deficient supplies. If a small deficit appears, the public dumps large quantities of purchasing power on the market in an attempt to obtain necessary supplies. The weight to be attached to the large issues of currency notes in an explanation of inflation, has been the subject of rather bitter discussions. . . . The position taken by the Government that the creation of notes was not the cause of inflation, was on the whole defensible. Proposals to limit notes in such periods are fanciful. Criticism may be justly placed on the shoulders of the Government for encouraging high real wages in a period in which they should have aimed to save supplies.

According to the author, the British pegging policy was "judicious," although it did not operate without some disadvantages since "more dollars were required for the purchase of American commodities."

The objective of England's deflation policy was to raise Sterling to the pre-war parity with gold, and therefore, the appreciation of the dollar, or its equivalent gold, made England's task more difficult; and the fluctuations in the value of the dollar are perhaps the most important single explanation of the fluctuations in Sterling from 1920–1925. The author's views here agree with Mr. Hawtrey, and this very important aspect of the subject is not treated extensively in Dr. Harris' book, since as the author says, "Mr. Hawtrey has presented this position well in his brilliant discussions of British monetary policy since 1914."

Fluctuations in the total purchasing power are not an adequate explanation of the price history of 1914–1919. In the early years of the War, the currency notes put into circulation were in large part substitutes for the gold formerly in circulation. The net addition of money was not adequate to explain the marked increase in prices 1914–1916. The fundamental explanation of the situation involves a thoroughgoing analysis of the data available on the balance sheet of the Bank of England, particularly the comparison of fluctuations in "other deposits," "government deposits," "other securities," "government securities" and the "special deposits" maintained by the Treasury for the public. Furthermore, in large part, the inflation is accounted for by the decline in production for "supplies were below normal in 1915–16" and this scarcity was more marked in 1917–1918. In the former period, the public disbursed their cash quickly and prices rose rapidly; while in the latter period markets were controlled and prices were "fictitious." Purchasing power was diverted from unlimited purchase of supplies to security markets and hoards.

An outstanding shortcoming of the book is the rash assumption that the readers understand the bank statements of the Bank of England, and the relationship of the items in this obscure summary of facts to the Treasury. The style and method of the presentation of facts and relationships is not clear and often extremely difficult to follow. It is not by any means a book for the general reader. It is too often necessary to refer to other sources for explanation of relationships implied. There is too obvious an attempt to avoid elementary explanatory digression such as a simple explanation of the relation between the Government, the Bank of England and the money market in words of two syllables, so to speak. The book is all meat and muscle and bones with no fat to give graceful curves and pleasing form to the penetratingly detailed analysis.

A high degree of skill and industry is shown in the examination and digestion of source material widely scattered and difficult of accessibility. In the face of almost insuperable difficulties, it is a highly commendable attempt to diagnose a situation through the statistical route which in general gives satisfactory results, but at times these are obscured by lack of sufficient and well-placed elementary explanations. Indeed, it may be described as a courageous venture in analysis through a maze of uncertain and poorly reported data with an extraordinary degree of detective skill; yet too often the very happy results are unfortunately hidden in part by the style and method of presentation. Many important deductions are not adequately explained and in fact not elaborated at all in some cases.

The book contains as an outstanding contribution an interesting and apparently penetrating analysis of "special deposits" together with an ingenious estimate of the volume of these special deposits from 1916 to 1920. But after all, the reader is still in some doubt as to the exact nature and functions of these special deposits. The author concludes that the special deposits were deflationary in effect on the money market and helped Sterling exchange rates.

The part on control of prices and supplies is especially good and clearly presented. Although necessarily brief, it is amazing how much detail has been included.

James G. Smith

Princeton University

Combines and Rationalisation in Germany, 1924–1928, by D. Warriner. London: P. S. King and Son, Ltd. 1931.

During the last quarter of the Nineteenth Century, while the movement toward monopolistic trusts was on foot in the United States, the industrial organization in Germany also became infected with the combination virus. But there, it took the form of the Kartell or cartel.

From the first, these cartels, varied in legal form from relatively loose associations to the complex structure of the so-called "double organization" providing for sale of the product through a special sales company. Since they were primarily producers' organizations, whose chief aim was to prevent the disorganization of the market for their products, the consumer of such products looked upon them as attempts to exploit him. This called forth defense cartels on behalf of the industrial consumer and consumer's coöperatives on the part of the ultimate consumer.

Up to the beginning of the Twentieth Century, German industry had been but little affected by the movement toward integration so prominent in America. But, within the decade following, this form of combination began to creep in slowly, particularly in the "heavy" industries, where it produced fissions in the memberships of many a cartel, because the demands of the integrated members were frequently in conflict with those of the unintegrated members.

During this pre-war period, orthodox theory, whose chief exponent was Dr. Robert Liefmann, developed its classical definition of a cartel as "an association between undertakings of the same kind which remain independent, whose object is the monopolistic domination of the market."

The post-war combination movement, however, follows no such simple and clear-cut lines. Industries had come out of the War in an impoverished and run-down condition. Individual establishments sought to strengthen themselves through combinations involving a stronger control over the estates of the combining units than could be procured through the cartel. Under the stimulus of the "Rationalisierung" movement integration was resorted to on a theretofore unheard-of scale. Industries in which integration was difficult also experienced a concentration of control established through the instrumentality of amalgamation and merger. Then, too, the rapid decline of the value of the mark, the break-down of the credit structure, and the difficulties of readjustment to post-war conditions made it necessary for the great industrialists to strengthen the financial framework of their enterprises through other than the usual means. Primarily out of such difficulties rose the monstrous, heterogeneous and ramified organizations which the Germans call "concerns."

But these changes in the structure of industry were not designed to supplant the older cartel. This form of combination became perhaps a less conspicuous, but, nevertheless, a very useful adjunct to the ownership combines. Still the exaggerated discrepancy in the size of members put the small producer in a very disadvantageous position, while the cartelized "trusts" caused grave concern among the consumers of their products.

Such then was the situation when German industry emerged from the inflation period and entered the stabilization period. The return to the gold standard necessitated the rapid deflation of values. The great concerns collapsed or were reorganized. The larger merged and integrated companies found themselves faced with the necessity of a new form of "Rationalisierung." Not only had they still to complete the process of technical reconstruction, but they had also to reconstruct their sales mechanism and their financial organization. Money for such purposes could not be procured in the domestic market and therefore they resorted to foreign loans.

Here again the small enterprise was at a serious disadvantage. Although it could become and usually was a member of some producers' cartel, it had practically no voice in the affairs of the combine. On the other hand, if it remained an outsider, it could shade the prices of the cartel and reap most of the benefits thereof without assuming the duties, expenses and obligations incident to membership. But should the cartel collapse, and the powerful integrated members resort to unrestrained competition, the small enterprise was very likely to be crowded to the wall.

It is this post-war period, with its technically well-appointed establishments, whose productive capacity far exceeds the restricted market, and whose policy it was to force the domestic consumer to maintain the income necessary to sustain the industry that has drawn the attention of Dr. Warriner. His book, entitled *Combines and Rationalisation in Germany*, is in the nature of a critique of German industrial organization during the period from 1924 to 1928.

Following an introductory chapter on the industrial and financial setting, Dr. Warriner proceeds to analyze the extent to which German industrial organization maintains an effective control over the market through its cartels. He points out that, even in the case of the heavy and finishing industries, the control over the market is subject to a great variety of influences (to some of which he reverts briefly) and comes to the conclusion that "it is possible to estimate the extent of control in the larger branches, as it is not in the group of industries excluded from that classification, that is, those in which wages are the principal cost—food, clothing, building and contracting, timber." Since the latter group employs some 5½ million of the 12½ million operatives and salaried staff employed in German industry, it is obvious that even a study of the heavy and finishing industries would not afford a basis for a general appraisal of the efficacy of control.

His second object is to enquire into the extent and scope of the so-called rationalization movement and the agents through which it was carried out. He points out that the term rationalization, as it is used in Germany, in truth, is planned industry (Planwirtschaft). It is applied to the technique of production in the form of the Taylor and other scientific management systems; it is applied to the adjustment of the technical and economic interrelation of enterprise to enterprise; to the financial structure; as well as to the interrelationship of industry to industry and to the consumer. Viewed from this standpoint, he concludes that "the outstanding and only example of genuine rationalisation is of course the scheme carried out by the chemical trust," which controls 90 per cent of the industry's total output. In this field, the author thinks that "all the most sensational results have been achieved by the trusts, though the great number of fusions only control a part of the total capital in the industry." "Rationalisation of an entire industry can be evolved with far more likelihood of success on the basis of agreement between large firms already internationally recognized than if the preliminary is complete fusion of a great number of dissimilar firms of varying levels of efficiency." "The cartel," he goes on to say, "is not as a rule a suitable instrument for reorganization, except as a preliminary, a guarantee that the work will not be wasted. . . . Thus the peculiar soundness of the combination movement in Germany and its suitability as a rationalising agent lies on a roughly worked-out balance of the two forms, possibly temporary in character."

But in certain industries even a temporary balance could not be worked out and here the state stepped in, introducing a forced cartel into the situation; for the German industrialist is accustomed to a wide field of state enterprise as well as emergency interference of the most varied character, state subsidies and management of industrial concerns, government campaigns to raise or reduce prices, compulsory arbitration, etc., and looks upon such action as a matter of course. The industries to which this sort of state interference applied were: (1) those whose voluntary organization is partly responsible for congestion of the market and that have not the power to improve the situation voluntarily, (2) those in which overproduction is directly due to the absence of organization, and (3) those that must face a catastrophic loss of market beyond their power of control.

In his appraisal of the achievement of the combines, he comes to some interesting conclusions. The German heavy industries are necessarily large-scale enterprises with heavy overhead costs, cartels formed in such industries invariably incur the danger of over-investment. This is particularly true of the steel, coal and cement industries. Transport costs also have received close attention particularly in view of the high railway rates imposed under the Dawes and Young plans. In this the cartel as the nucleus of concerted action has brought about very satisfactory results, particularly in the coal industry of the Ruhr which turned to water transportation. The cartel, too, in exceptional circumstances, can undertake the direct provision of capital as it has done with great effect in the brick making industry, or can effect a conservation of limited working capital by regulating terms of sale, or by providing special credit facilities.

In the matter of regulation and extension of the market, Warriner says that nothing could be more untrue than the accusation that the cartel tends to take demand for granted and adjust supply to it. Yet it is hampered in its efforts to extend the market because it cannot use ordinary methods of advertising. To which might be added that where a central sales agency is used there is a tendency toward lack of aggressiveness coupled with a rise of bureaucracy. As aids in the development of the foreign market, particularly in Russia, many cartels have shown satisfactory results. But, for the most part, again, the greatest success has been attained by the heavy and finishing industries.

In considering the effect of combination upon industrial conditions generally the author analyzes the policy pursued with respect to wages and prices. Pre-war practice, in general, followed the principle that costs are determined by prices and hence wage adjustments followed price movements. In the post-war period the procedure had to be reversed and prices were determined by costs, the latter being more or less determined by the wage rates set by the state. This shift is particularly noticeable in industries in which labor costs are important constituents of final cost.

The attitude of the state toward the combination movement is also given attention. Here Dr. Warriner sees in pre-war days a definite and rather unswerving policy, based largely on the idea that cartels were factors in the development of the home and export market. This policy was one of condonance. Since the War, however, strong attacks have been made upon the producers' combines which were accused of abuse of economic power, and finally laissez-faire gave way to regulation.

In November, 1923, the Reichstag passed the act regulating cartels and trusts. But apparently neither the courts nor the framers of the act knew precisely what it meant. In general, the act authorized the recision of the cartel agreement where the member can show injury resulting from the cartel policy. The courts also appear to have followed the example of the American tribunals in condemning discriminating rebates and other unfair trade practices. On the whole, the author seems to feel that this legislation has not given very satisfactory results and has created a demand for a revision. The chief obstacle in the way of satisfactory legislation, in his opinion, is the absence of a definite theory applicable to this form of industrial organization. Under post-war conditions, the old definition of a cartel no longer holds and we find Dr. Isay defining it as "an association of independent undertakings, which enforces obligations as to the treatment of output, market, purchase, price calculation or trade terms and therefore serve to influence the market against the working of free competition." After reviewing briefly German economic theory on the subject, Dr. Warriner concludes by saying,

> If German public opinion can find no coherent principle to assist it in the revision of the cartel legislation (universally recognized as necessary), it is not due to a mere difference of opinion among economists, but to a much deeper opposition between two methods of approach, both of which are indispensable to an understanding of the combined problem, yet which cannot be combined. Behind their opposition lies the theoretical antinomy between theory which treats the dynamic elements as friction and theory, which, in giving the dynamic forces their proper treatment, loses all general principle. So long as it persists, there can be no consistent attitude to the combine movement.

A. H. STOCKDER

Columbia University

Laboratory Handbook of Statistical Methods, by Theodore Henry Brown, Richard F. Bingham, and V. A. Temnomeroff. New York: McGraw-Hill Book Company. 1931. 244 pp.

There are two main parts to the body of the text, the first an eighty-eight page discussion of graphic methods, the second a slightly longer treatment of mathematical methods. In Book I the first chapter deals with basic principles of charting; the second outlines the construction of grids specifically adapted to the individual chart and methods of lettering. Then follow fifteen chapters on different types of chart. Each of these chapters treats topically the purpose of the chart, its construction and its interpretation. The final chapter presents exercises and problems.

The treatment of graphics in this section is decidedly superior to that in the most widely used texts on statistical methods. It is more concise than the standard treatises. The precisely repeated form of each chapter and its limited scope make the material easy to use.

The subject matter of Book II is that usually covered in a text on method. In each chapter there is a condensed statement of general principles, followed by a case that at once illustrates the mechanics of calculation and discusses the principles involved. For laboratory exercises there is general reference to Mills or Chaddock. It is also supposed that for established details of statistical practice the student will turn to recognized authorities. For example, in the chapter on the frequency distribution there is no statement of the problems of constructing a frequency distribution nor any discriminating discussion of the applicability of different types of average.

In contrast with this chapter, which covers the most thoroughly developed phase of statistics, the one on trend is almost complete in itself, except as regards mathematical background. There is a good discussion of the general concept, an adequate treatment of the process of fitting the more common curves, and the best simple exposition of the Gompertz curve that has come to the reviewer's attention.

The work is obviously designed to serve the approach used in the Harvard Graduate School of Business Administration. As a single volume it is inadequate, being neither an exercise manual nor a text. It is intended to supplement a case book which presents business uses of statistics rather than method. It in turn is to be supplemented outside the laboratory with comprehensive texts.

A. F. HINRICHS

Brown University

Brokers Loans, by Lewis H. Haney, Lyman S. Logan and Henry S. Gavens. New York: Harper and Brothers. 1932. 241 pp.

One of the most spectacular epochs in the eventful history of American banking has been the past decade, and the outstanding event of this period was the tremendous expansion and contraction of brokers loans. The credit demands of the stock market have always played a peculiarly important rôle in our money-market structure, but never before were these demands so predominant and so far reaching in their influence. Professor Haney and his associates have written what is probably the first book dealing primarily with brokers loans to be published after the crisis.

This particular book is primarily a statistical analysis of some of the aspects of brokers loans. The early chapters, which explain the nature of brokers loans and describe the various sets of available statistics, contribute to a better understanding of the problems presented by these loans and will be particularly useful for reference purposes.

In Chapters IV to VII a great many ratios and barometers are presented and some of them are employed as the basis for further analysis. Some, lacking any significance, are left properly without comment. In other cases interesting relationships revealed are only slightly discussed. The general reader, not interested in statistical manipulation, may omit these chapters and proceed to Chapters VIII and IX which analyze some of the problems encountered in 1928 and 1929 and the steps taken to deal with them. The final chapter discusses the regulation of brokers loans.

In the statistical sections the familiar correlation between brokers loans and stock prices is shown and analyzed, and a barometer of some forecasting significance is presented. Available statistical comparisons seem to indicate that new security issues have some effect on brokers loans, but probably not as much as sometimes believed. On the whole, the statistical data appear too limited to support final conclusions regarding the various factors influencing brokers loans or influenced by them.

The analysis of the sources of brokers loans by others shows how these funds originated in developments largely peculiar to this period. Of these corporation financial policy and the issuance of new securities on the favorable stock market were probably the most important. The effect of general credit expansion based upon earlier gold receipts is not mentioned.

Failure of the authors to take into consideration one of the fundamental aspects of brokers loans leads to some misconceptions of the operation and effect of these loans. It may be considered an ultimate principle that fluctuations in brokers loans reflect the cash requirements of brokers—when brokers need to pay out or hold in cash more funds than they receive, they must increase their borrowings while excess cash receipts permit a reduction in borrowing.

Disregard of this principle led to the conclusion that brokers loans are directly affected by changes in stock prices and by the volume of margin trading—a conclusion supported by statistical correlations. Margin traders, however, may trade at will entirely among themselves and raise or lower stock prices without any necessary effect upon the net borrowings of brokers. These borrowings are affected only by net payments or net receipts of funds by brokers. It is true that price changes and volume of margin trading are important influences determining these payments and receipts, but it is important in analyzing the significance of brokers loans to keep the intermediate steps in mind.

There is a further misconception regarding the effect of brokers loans upon the volume of bank credit. The authors seem to think that the increase in loans by others was responsible for the decline in bank deposits during 1928 and 1929. So far as loans by others represented a taking over of bank loans to brokers, such a view may be supported, but since additional lending reflects an excess of outpayments by brokers, it may be presumed that the funds paid out would be deposited by the recipients. A decline in bank deposits may reflect a decrease in bank loans or investments, an increase of currency in circulation, gold exports, or liquidation of reserve bank credit, but not a shifting of funds among different users.

There is a similar misconception regarding the effect of brokers loans in general upon the supply of funds available for business. The authors' contention that funds put into circulation by brokers loans may not be made available to business if they return to the stock market is perfectly justified, and to some extent exactly that happened, especially in 1929 when corporations sold new securities to margin traders and loaned the proceeds to brokers. To a large extent, however, the funds obtained from an increase in brokers loans are paid to sold-out investors and speculators, who are taking profits to spend, or to corporations issuing new shares for funds to be used in business expansion. This undoubtedly happened in 1925 and in 1927 and to some degree in other years. Both the greatest dangers and the chief benefits of brokers loans lie in this ability to increase and decrease the credit supply. The rôle of velocity of bank deposits, which was tremendously important in 1928 and 1929, is also ignored by the authors.

Proposals for regulation discussed in this book deserve careful consideration. Absolute prohibitions are undesirable, partly because some brokers loans are necessary and useful and partly because, if the reward is large enough, the prohibitions will be circumvented by the use of new sources or channels. Proper emphasis is placed upon the need of controlling the demand for loans, as represented by speculative activity, as well as the supply of credit available for such loans. Among the proposals analyzed and recommended are the fixing of maximum limits on expansion, as in 1918, and the restriction of margin trading. The authors believe, however, that existing agencies, without any fundamental changes in present arrangements, could check speculative movements if action is prompt and drastic enough.

WOODLIEF THOMAS

Medical Supervision and Service in Industry. New York: The National Industrial Conference Board. 1931. 125 pp.

Nearly forty-eight millions of our people are gainfully employed. The large majority of them gain their living in industrial groups. Is the employee group an effective social unit for organized efforts to promote health? And is the employer an appropriate instrumentality through which social responsibility for public health is to be discharged? These questions will arise in the mind of the thoughtful reader of this report.

The Conference Board answers both these questions in the affirmative, finding that industrial health work is justified because it fulfills the dual functions of contributing both to industrial and social advancement. Thus, the employer who conscientiously and scientifically carries on a health program in his establishment with a view to reducing his expenses for accident compensation indirectly promotes the public health. More sweeping claims are made for the benefits derived by the employer in the statement that "aside from the sociological benefits resulting from the improved medical care of employees, there has been a reduction of compensation costs and of waste involved in excessive labor turnover, absenteeism and low labor efficiency."

The report contains detailed information concerning the medical departments of 443 companies employing 1,125,839 workers. Although the sample studied is a relatively small and highly selective one, this in no wise diminishes the value of the information to employers who wish to know more about the practical problems of an industrial health program.

The Conference Board notes a gradual shifting of emphasis from curative phases of medical care to preventive work and health education. But just what is the distinction between preventive and curative medical work? An effective cure must have in it something of prevention. On the other hand, no system of medical care can claim to be fully preventive.

"Hygiene," rather than medical service, is perhaps a better term to describe what is being done through industrial programs. However, one weakness of industrial hygiene is brought out clearly in the report. An employee who complains of "not feeling well" may have his complaint diagnosed by the plant physician. In most instances, something in the nature of therapy will be administered. However, the moment the sick employee leaves the plant, the contact between him and the diagnosing physician is broken. Rarely does the doctor employed by the industrial concern follow the employee into his home to give him treatment for sickness. Even if the employee calls in a physician (and studies by the Committee on the Costs of Medical Care indicate that all too often he does not) the process of diagnosis and treatment must begin afresh. Effective health work, in the opinion of this reviewer, must be organized primarily around the family. It is questionable whether the employer is on sound ground when he confuses the private profit resulting from an employee health program with the social welfare. The social welfare must be consciously and deliberately sought through social planning, and society must undoubtedly make use of the industrial plant as an agency for promoting its welfare. Under present conditions it may be necessary to accept whatever improvements in social conditions come about accidentally as by-products of private profit making, but let us not be misled into mistaking the shadow for the substance.

If health is to be regarded as an important social asset, then the organization for promoting health must be social. In the field of industrial hygiene, this means that the health program should be an employee group activity; better still, a specific application of the principle of employer-employee participation in management. However, this view of industrial health work is as yet held by few employers.

Pierce Williams

National Bureau of Economic Research

Branch, Group and Chain Banking, by Gaines T. Cartinhour. New York: The Macmillan Company. 1931. 351 pp.

Some books are important contributions to the literature of a particular field because for many years the fundamental principles set forth continue to guide the activities of mankind in some important respect. Professor Cartinhour's book does not fall into this class. He does not attempt the fundamental task of analyzing critically our banking and credit system and its relation to economic welfare as a whole. He gives us no comprehensive analysis of the painful inadequacies which, in view of the events of the last few years, must of necessity exist. He has set for himself a lesser task, and to this task he has brought good craftsmanship, keen discrimination, and balanced judgment.

The historical development and the present activities of chain, group and branch banking organizations, and a critical weighing of the advantages and disadvantages of each form of multiple banking, constitute the chief object of this study. From a great variety of sources Professor Cartinhour has brought together a large body of information concerning banking in small cities and towns, the earning power of small banking institutions, bank failures, types of branch, group and chain systems and their history from 1890 to 1931, together with material showing the actual functioning of the various multiple systems now in operation.

The advantages of group and branch banking, in so far as they may serve to replace unit banks in smaller cities and rural sections, are ably set forth. The Preface is dated March, 1931, and developments since that time indicate rather conclusively that safety and good banking are not necessarily concomitant elements of size alone. During 1931 there were numerous failures of fair-sized banking institutions in the larger cities, and many additional failures were avoided by mergers and consolidations. These developments do not by any means invalidate the author's arguments, for it still remains true that the percentage of failures of larger banks was much lower than it was for smaller institutions.

Professor Cartinhour takes up and in large measure refutes most of the arguments commonly advanced against group and branch banking. He concludes that both group and branch banking are fundamentally sound. Because of tremendous geographical area and sectional and economic differences he believes that (p. 300):

> What may be beneficial for one region is not necessarily beneficial for others. It is possible that a type of banking which [illegible] in one section might be unsatisfactory if forced on another. . . . Various types of banking should be permitted to develop in any part of the country in accordance with the requirements of industrial and business interests. This would dispense with the administrative difficulties of defining trade or economic areas but would call for a relaxation of laws with respect to the development of the various types which appear to offer promise of sound development . . . assuming of course that adequate statutory and administrative facilities exist for supervisory purposes. . . . The laws against branch banking should be relaxed or removed entirely. . . . Any form which cannot be efficiently supervised should not be allowed to develop.

The timeliness of a study of this sort is apparent. It becomes clearer every day that there must be some fundamental changes in our banking structure. In so far as legislation is a necessary precedent to such changes this book should prove a valuable reference work. It can scarcely fail to be helpful, also, to bankers and business men who have it within their power to adopt some form of multiple banking. In this sense the book may be said to have importance of something more than a transitory character.

University of Michigan R. G. Rodkey

Problems of the Pacific, 1929, edited by J. B. Condliffe. Proceedings of the Third Conference of the Institute of Pacific Relations, Nara and Kyoto, Japan, October 23 to November 9, 1929. Chicago: University of Chicago Press. 1930. xv, 697 pp.

This is the second volume of papers under the title *Problems of the Pacific* which Professor Condliffe has edited most admirably. The first, also published by the University of Chicago Press in 1928, contained the proceedings with summaries of the round table discussions and reprints or abstracts of many of the documents and addresses of the second conference of the Institute of Pacific Relations at Honolulu in 1927. The Institute was organized and held its first conference in Honolulu in 1925. Its biennial conferences are only a part of a continuing process of study and research carried on by the national councils of the member countries bordering on or having important interests in the Pacific. Thus each succeeding volume of Proceedings represents a cumulative experience and the cumulative results of well directed research to meet the needs for unbiassed information and accurate knowledge concerning the problems revealed in the conference discussions.

Dr. Condliffe may well be congratulated upon the achievement of having published within less than seven months from the date of adjournment of the third conference this large volume containing his excellent summaries of the discussions and reprints or abstracts of the principal data papers, materials and addresses presented to the conference. The chief interest and importance attaching to this volume at the time of its publication, and even more so now, twenty months later, by reason of recent events which have centered world attention on Manchuria, will be found in the three hundred and more pages, nearly half the entire volume, devoted to the problems of Manchuria. Although during this interval the fourth conference of the Institute has recently been held in Shanghai, it will be still some months before its Proceedings will be published, and Manchurian questions were almost entirely excluded from the discussions as a condition which made the holding of the conference at this time possible.

Accurate statistical data are so difficult to obtain for most Asiatic countries that it is surprising so much factual information for the understanding of the economic background of this new international area of Manchuria in which the population pressures of Russia, China and Japan converge, could have been assembled in the biennium between the second and third conferences of the Institute. This area was referred to as the most rapidly developing frontier region of the world of today, and the triangular rivalry of the powers whose populations are most concerned is further complicated by the interest of the great Occidental powers in the trade and commerce of this region, and in the maintenance of the Open Door policy. Mr. Chu Hsiao, the Director of the Society for the Study of the Northeastern Provinces, at Nankai University in Tientsin, over which Chang Po-Ling presides, gives us an excellent statistical survey of the resources, industries, trade, railways, and immigration, of Manchuria; and this is followed by another forty pages of text by Professor C. Walter Young, of George Washington University, on Chinese Colonization and the Development of Manchuria. There are two comprehensive papers, each over sixty pages in length, presenting authoritatively a scholarly exposition of the respective Chinese and Japanese points of view in the interpretation of this descriptive material, the first by Shuhsi Hsu, Professor of Political Science in Yenching University, and the second by Masamichi Royama, Professor of Public Administration in Tokyo Imperial University. The latter is well documented statistically and with respect to source material regarded as specially important by the Japanese.

There is in addition to the above materials relating directly to Manchuria, a brief paper by Yosuke Matsuoka, formerly Vice-President of the South Manchuria Railway Company, which shows quite conclusively that only peaceful economic coöperation of Chinese and Japanese can assure the development of Manchuria for the benefit of its citizens who are and will be for the most part increasingly Chinese, and for the protection of Japan's major present and future interests in that country.

Many of the papers presented for discussion at other round tables of the conference, notably those on Food and Population in the Pacific, on Industrialization in the Pacific Countries, and on the Financial Reconstruction of China, some of them of no little statistical significance, have important indirect bearing on the problems of Manchuria. It is doubtful whether any International Commission of Inquiry into the distressing events and conflicts of recent months in Manchuria could add much to the factual knowledge contained in this volume, or would need much more than it will find here to reach conclusions that will at least point the way to a solution less costly and wasteful than military operations, boycotts or other instrumentalities of force, hatred and destruction by whatever name they are employed.

What has just been said of the serviceableness and timeliness of the parts of this volume relating to Manchuria is equally true of the rest of the book in relation to the problems of the Pacific. The Institute has clearly demonstrated the public gains to be expected from the machinery and methods it has inaugurated for the unofficial, unbiassed and untrammeled examination and discussion of great public interests, which hitherto have been allowed to drift into conflicts and misunderstandings surcharged with angry and often hereditary passions. It is high time for governments to build upon the results of such efforts and to develop corresponding machinery and methods for dealing with official relations and solutions having the sanctions of law and an enlightened world opinion. Perhaps it may not be too late for some such counsels yet to prevail in China, Japan and Manchuria.

Samuel McCune Lindsay

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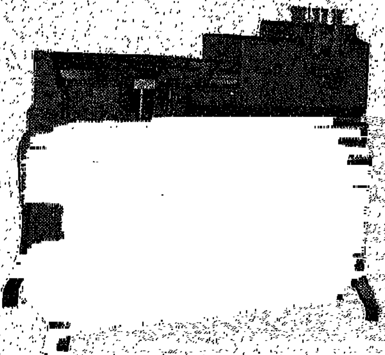

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GOLD, INTERNATIONAL CREDITS AND DEPRESSION[1]

By James Harvey Rogers

PART I

British economists have frequently pointed out important relationships between the international gold situation and the current depression. In amplified form their argument is usually somewhat as follows.

In gold standard countries, the monetary units are defined as given weights of pure gold. In the United States, for example, the dollar is defined as 23.22 grains of fine gold. Moreover, having been thus defined, careful provision has been made to maintain the definition. If anyone has gold, he may, by taking it to one of the government offices, receive in return dollars, one for each 23.22 grains of fine gold. If, on the other hand, he has dollars, he may demand gold coins or gold bars in exchange and thus receive 23.22 grains of fine gold for each dollar presented.

In other words, gold and dollars are kept completely interchangeable—23.22 grains of fine gold being kept always interchangeable with one dollar.

Because of this simple but invariable relationship, it follows that the value of this given weight of gold is always exactly equivalent to that of a dollar and vice versa. Whatever happens, therefore, to the value of gold happens automatically to that of the dollar and whatever happens to the value of the dollar happens equally automatically to the value of gold.

Suppose, for example, that gold should become as plentiful and as cheap as copper, the dollar—important lags for the moment being disregarded—would become equally cheap and would buy correspondingly little. If, on the other hand, gold were to become greatly in demand without equally great increase in the supply, its value relative to that of other things would rise correspondingly, and so would that of the dollar.

---

[1] Part I of this paper was delivered before the Annual Meetings of the American Statistical Association in Washington, December 30, 1931. Part II has been added as of June 15, 1932.

That there is just such a greatly increased demand for gold in the world today and that the supplies available for those needing it most urgently have at the same time become more difficult to obtain, I shall now proceed to add to the usual argument just given. In fact, among the civilized nations of the world there is a veritable scramble for gold and the drastic price declines from which, for more than two years, the world has been suffering, is in no uncertain way connected with this scramble.

Of the approximately 400 million dollars worth of gold mined each year, roughly one-half goes into the arts to be made into watches, table ware, and jewelry, and to be used in filling teeth. The other half goes automatically into the monetary gold stock of the world—there to serve as a basis for our money and credit systems. This enormous gold reserve now amounts to a little more than eleven billion dollars.

Where, then, you may ask, is there any possible shortage? The answer is: There is no actual shortage for all the gold-standard world taken together, but this huge existing stock is so badly distributed that while, in two countries, large unused supplies lie locked up and idle, in many others, there is too little to maintain the standard.

The United States, for example, even after its recent great losses, holds 36 per cent of the world's total and France 22 per cent. England, on the other hand, holds barely 6 per cent and Germany less than 3 per cent. Moreover, a situation very similar to the one just described has existed for several years, with the United States and France claiming an ever larger portion of the total. The charts give in more detail the present (March 31, 1932) character and continued growth of this extraordinary maldistribution.

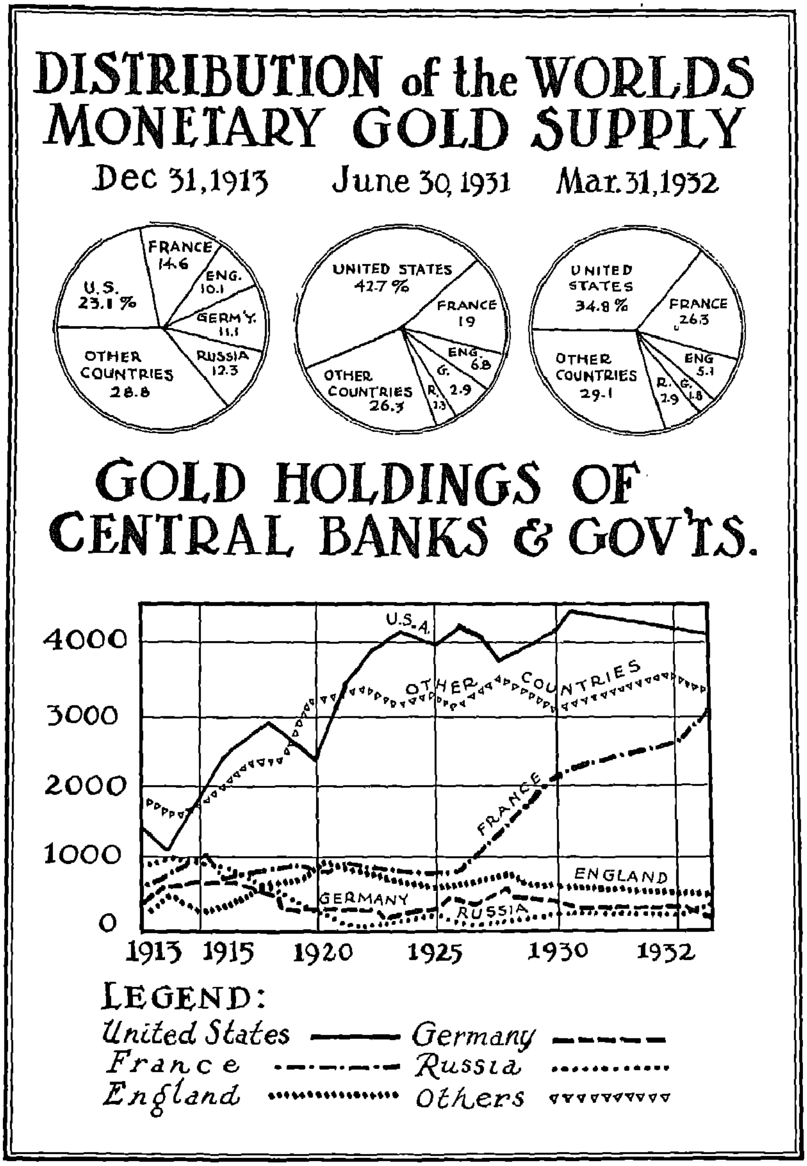
The difficulties experienced in emergency by a country suffering from a gold shortage are perhaps best exemplified by those recently confronted in England and in Germany.

In England, during a number of months prior to the collapse of the gold standard, it became more and more generally known that the entire British gold stock was less than enough to pay the short-term credits held in London by Paris bankers alone.

In Germany, at the same time, it became known that the total of foreign short-term credits in the Berlin market was more than five times the gold holdings of the central bank of that country.

Since a great portion of such short-term credits can be withdrawn literally overnight, the danger of being thrown suddenly off the gold

CHART I



standard was continually imminent in both of the countries mentioned. Moreover, in all the big money and investment centers are sold many internationally-held securities. Once a gold standard is threatened, the sale of securities in the distressed country and the purchase of those payable in more certainly stable money units increases the ever more dangerous gold outflow. Under such circumstances, the possibilities of political pressure from abroad are as evident as are the uncertainties in the credit structure and in the securities' markets of the threatened country.

The evils of a gold shortage, therefore, while often unnoticed until some jolt to international confidence appears, are thus ever-present in the form of a threat to economic, to political, and even to diplomatic security. Strenuous and persistent efforts therefore are made to remove them.

The quickest and often the easiest way to build up a waning gold reserve is, through central bank action, to stimulate a rise in short-term interest rates. Funds are thus attracted from abroad and usually bring with them a gold inflow. In periods of stress, however, when confidence has already been shaken, not only does such a device often fail to bring the expected relief, but whatever relief is thus found intensifies the threat of short-term credit withdrawal.

More permanent and immediately less dangerous devices are therefore sought. If exports can be increased relatively to imports much more stable and satisfactory relief is found. Hence strenuous efforts are made to throw all the goods possible on the international markets and to take as few as possible therefrom.

To stimulate exports, bounties and dumping of one sort or another are instituted.

For reducing imports, the most ready device is the protective tariff. Moreover, in periods of falling prices, like the present one, it is especially popular because it gives *apparent*—though usually only apparent—promise of raising directly internal prices at the same time that it attracts gold from abroad. Hence, in the period of our history when international communications have made their greatest advances, the world is fast becoming a series of walled estates not unlike those of the Dark Ages.

To gain additional control over international trade balances and hence over gold movements, many countries have gone further still. Central banks have been given more and more complete control over the foreign exchanges and many imports are arbitrarily cut off by a refusal to grant the exchange required for payment. To these have been added no less damaging "*import quotas.*"

It is to such vicious and highly damaging mediaeval policies that the gold scramble, in combination with other influences, is leading. Meanwhile, the price level has continued its tragic decline and the business of the world has become more and more depressed.

In the United States, the gold scramble has taken several unusual and, I am afraid, unnoticed forms.

The migration of American industry, which by the end of 1930 had already reached appalling proportions, seems to be increasing at an accelerated rate. Certainly, the growth of ever higher tariffs and other trade restrictions in many parts of the world—notably in the British Empire—have provided ample encouragement. Thus, during the deepest depression of which we have reliable records—while American raw materials, of their usual high quality, flood our markets and American laborers, as dependable, as efficient and as anxious to work as ever, clamor for non-existent jobs—American firms with gigantic purchasing and employing power are fast seeking new homes in foreign lands.

Meanwhile, with the continued scarcity of so-called "free gold" in our banking structure, Federal Reserve credit policies—which, throughout the depression have been at least halting and spasmodic in the direction of monetary ease—seem to have taken an abrupt change toward relative tightness. Thus, with 36 per cent of the world's total gold stock we seem to have entered directly the scramble for a still larger share of this much sought metal.

Under such circumstances not only are we no longer exerting our influence to relieve the world's distressing monetary conditions, but our ponderous weight bids fair to be added to the already grave pressure toward further price declines.

The relation between falling prices and depression requires but little comment. As business is at present organized, costs in general precede selling prices. If, during the process of production, selling prices so decline as to fail to meet previously incurred costs, profits are automatically turned into losses and many businesses are forced to close.

One other often forgotten influence is of equal importance. Far from being entirely flexible and hence adjustable to changing conditions of all sorts, our price system contains prices of every degree of rigidity. On one end of the scale are those completely flexible, adjusting themselves readily to happenings, or even rumors of happenings, in any part of the world. On the other end, are those of almost complete inflexibility, changing only to meet the rulings of a bankruptcy court. If the price of your product is among the highly flexible ones while your costs —as is frequently the case—are highly inflexible, your profits, in periods of rapidly falling prices, are likewise automatically turned into losses. And the more rapid and more drastic the declines, the greater and more general will the losses be.

Whatever may be said, therefore, as to the so-called causes of the depression, of this we may be confident: *Until the drastic and rapid decline of commodity prices can be at least arrested, business recovery on a broad scale can hardly be anticipated.* In consequence, it is of the utmost importance that potent measures to this end be adopted.

If the gold scramble is to be relieved, the existing supplies in France and in the United States, where plentiful, will have to be more effectively used.

To be more effectively used, measures must be taken to make them support a greater credit and money super-structure.

Very fortunately, our excellent Federal Reserve System provides the machinery for just such measures. Through open-market purchases of bills and of government securities, if maintained courageously and with persistence, these central banking institutions have it within their power to bring early, if only partial, relief.

Such purchases put entirely new funds into the hands of the sellers. If the seller is a banker, he thus increases directly his lending and investing power; if an individual (or firm) he deposits the proceeds in his bank which thus gets a similar though indirect enhancement of its lending position. Even if—as frequently happens—the receiving bank uses the new funds only to pay existing indebtedness at the Federal Reserve Bank or with a city correspondent, the enhancement of its lending position—and more important still—of its power to command the confidence of its depositors is just as great. Moreover, in a period of disastrous liquidation, like the present one, the receipt of such additional funds in the form of new deposits removes for many hard pressed banks the painful necessity of selling their best and most liquid investments on a weak and declining market.

Unfortunately, however, one dangerous obstruction to the pursuance of such a policy has made its appearance. Directly connected with the international gold scramble above described, it seems to have appeared in more nebulous and hence more insidious form to those charged with the operation of our money and credit systems. Indeed, one cannot but wonder whether the sometimes ingenious but usually unconvincing rationalizations of a "do-nothing" policy on the part of our central-banking authorities in the present emergency do not—often unconsciously perhaps—merely cloak this important but little understood restrictive influence.

As mentioned above, the "free gold" in our Federal Reserve Banks, during the past few months has averaged but little more than half a billion dollars. Thus, at a time when our monetary gold holdings amount to more than 35 per cent of the entire world stock, our credit policies are actually being gravely influenced by a virtual gold shortage.

How is it possible for such an extraordinary state of affairs to arise?

In our Federal Reserve System, gold has *two* important uses. The first is as reserve—40 per cent gold against notes and 35 per cent gold or other "lawful money" against deposits.

The second is just as simple though perhaps less generally understood. Federal Reserve Notes must be collateraled either by "elligible paper" ("Bills discounted" and "Bills bought on the open market" [1]) or else by gold. The fact that the gold thus pledged against notes can be counted likewise as reserve does not under present extraordinary circumstances relieve the severe strain which this often forgotten use places upon our gold supplies. Indeed, it so happens that in recent months "elligible paper" in the Federal Reserve Banks has been so scarce that a very large proportion of our Federal Reserve Notes outstanding have been necessarily covered by gold. Moreover, any additional issue of such notes, unaccompanied by a like increase in "elligible paper" in the vaults of the Federal Reserve Banks would further reduce—dollar for dollar—our small and fast waning "free gold" stock.

In such a situation, the large foreign balances held in New York have given natural but often undue concern. The possibility, through the recall of such credits, of a sudden withdrawal of upwards of 600 million dollars by the French—and perhaps of an equal amount by all others together —has at times been disquieting. Nor does the fact that a considerable portion of these funds are at present invested in bankers' acceptances bought on the New York market completely allay well-founded fears. While such "bills" released by foreign holders would undoubtedly be purchased in large part by the Federal Reserve Banks, which would in this way restore the available "free gold" to the extent of such purchases, the net loss might prove disturbing.

Two other features of the situation bring no reassurance. The large holdings abroad of American and of other securities salable on the New York market furnish an added threat in case confidence in our ability to maintain the gold standard should further wane. Heavy sales of such holdings would bring an added draft upon our gold supply.

Would such a draft be accompanied by a release of roughly equivalent amounts of "free gold"? The answer is: Under present circumstances it probably would be—especially if the withdrawals were sudden.

The reason is that such withdrawals would be largely counterbalanced by accompanying forced "rediscounts" on the part of member banks faced with the necessity of providing the funds being turned into gold for export. Should the security sales be gradual and slow, however, hard-pressed banks would probably continue their recent policy of meeting many such demands by a further liquidation of their loans and investments. Thus, from a double source, would the situation in the securities markets be further aggravated, and general credit continue its rapid contraction.

---

[1] These terms are used in the special senses given them in the statements of the Federal Reserve Banks.

Should panic conditions result, even a "flight from the dollar" by Americans is conceivable, and hoarding would certainly increase greatly. Moreover, while each of these drains on our gold supply would doubtless be to a considerable extent counteracted by a further expansion of forced "rediscounts" and hence by corresponding increases in available "free gold," the alternative further contraction of loans and investments on the part of many banks meeting the withdrawals would continue the vicious spiral of liquidation.

Under such circumstances, large purchases of government securities by the Federal Reserve Banks—unless effective in restoring business health with entirely unhoped for rapidity—would certainly reduce further the "free gold." The reason is not far to seek.

Almost invariably such purchases have in the past led to a similar reduction in "rediscounts" on the part of the member banks. In other words, the new funds put out to the banks through open-market purchases, have been in general returned by them through paying of their indebtedness at the Federal Reserve Banks. Hence, while there is no doubt that such cancellations of indebtedness improve the lending position—as well as disposition—of the bankers concerned, it is equally evident that the loss of "elligible paper" by our central institutions reduces by a like amount the available "free gold."

Hence, under current conditions, further purchases of government securities by the Federal Reserve Banks would increase their demand obligations at the same time that it would decrease their capacity for meeting them.

Thus with our enormous gold holdings we find ourselves in the preposterous and—were it not so tragic—ludicrous position of having to adapt our internal credit policies to the demands of a threatened gold shortage. On this account the most constructive proposal yet made for relieving domestic as well as international money and credit conditions has at least temporarily been precluded. And the United States has actively entered the gold scramble.

Meanwhile the gradual drift of world economic affairs under a passive credit policy in this country is to a no less tragic and uncertain state.

To dissipate once and for all this extraordinary "gold scare" and to make possible again the free and intelligent utilization of our enormous gold stocks, the means are as simple as they should be easy of attainment. What is alone needed is that in emergency the "cover" requirements for our Federal Reserve Notes be liberalized. Just as it has been provided from the beginning that all *reserve* requirements may at the discretion of the Federal Reserve Board be suspended for thirty days and re-suspended as often as required for fifteen days at a time, so a similar provision should be incorporated making legal the emergency use of government securities as "cover" for Federal Reserve Notes. Certainly, it is preposterous to provide carefully against embarrassment from a sudden temporary shortage of gold in one of its two uses and at the same time to leave ourselves completely unprotected from the dangers of a similar shortage in the other more rigid and more exacting use.

Some such modification of the Federal Reserve Act is the *sine qua non* of any constructive credit relief in this country.

PART II

Since Part I of this paper was written almost six months ago, much water has gone over the mill.

The Glass-Steagall Act, providing in emergency the necessary liberalization of the "cover" requirements for our Federal Reserve Notes, has become law. Through its application more than a billion dollars have been added to our "free gold" stock, which otherwise would now be less than zero.

Credit expansion through open-market purchases by the Federal Reserve Banks has become the avowed policy of our central banking system as well as of the national government. Beginning in late February, approximately 25 million dollars a week were added to Federal Reserve holdings of government securities. Moreover, after April 6 these weekly purchases were advanced to approximately 100 million dollars and were thus maintained for six successive weeks.

However, as the purchases continued on this advanced scale, not only was the entire policy subjected to more and more vicious criticism, but increasing gold outflows caused alarm in many circles. After May 18, the policy was continued only on a much reduced level. Since that date, gold exports alone have more than counteracted the further open-market purchases. Hence, for the past four weeks, the credit expansion policy may be said to have been discontinued. Indeed in the minds of superficial observers it has been tried and found wanting.

Thus was an entirely new experiment in central banking policy initiated, pursued mildly, stepped up vigorously, and finally virtually suspended. To what extent was a scientific test made? What has been learned? In what respects was the policy found fruitful and in what others did it prove wanting?

A quantitative analysis of just what has occurred should prove illuminating.

First a dissection of Federal Reserve credit will be made. The amounts of each kind outstanding on February 24, 1932, will be compared with those of June 8, 1932, and the changes noted.

TABLE I
FEDERAL RESERVE BANK CREDIT
(in millions of dollars)

	February 24, 1932	June 8, 1932	Change
Bills discounted	835	502	−333
Bills bought	133	36	− 97
United States securities held	741	1,645	+904
Other reserve bank credit	25	16	− 9
Total reserve bank credit	1,734	2,199	+465

It will be seen that out of the very large purchases of government securities ($1,645 millions) during the period, only a comparatively small proportion ($465 millions) remained as a net accretion to Federal Reserve credit outstanding. As anticipated, a very large proportion ($333 millions) of the total was consumed through the repayment of member bank borrowings from our central banking institutions.

Further light will be thrown upon the experiment by next considering quantitatively all the various kinds of "basic credit"[1] in the United States and how they have been utilized. The amounts of each and the net changes during the period under discussion are given in Table II.

TABLE II
SOURCES AND USES OF CREDIT IN THE UNITED STATES
(in millions of dollars)

	February 24, 1932	June 8, 1932	Change
Sources of Credit			
Total reserve bank credit	1,734	2,198	+464
Monetary gold stock	4,350	3,979	−371
Treasury currency adjusted	1,780	1,796	+ 16
Total	7,864	7,973	+109
Uses of Credit			
Money in circulation	5,592	5,452	−140
Member bank reserve balances	1,878	2,112	+234
Non-member deposits, etc.	395	409	+ 14
Total	7,865	7,973	+108

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[1] By basic credit is meant that upon which the banking system can in turn "base" its expansion of loans, investments, and deposits. Its items are given in Table II.

How much of the net Federal Reserve expansion, shown above to have been salvaged from the total of "open-market" purchases was in turn consumed by changes in these factors is clearly evident. On the evening of June 8, the total accretion to the credit base upon which is anchored our entire money and credit structure was but 108 million dollars. Indeed, except for cash returned from circulation during the period, there would have been an actual decline in the credit base. Only because of the release of 140 millions of hoarded cash, was the substantial increment of 234 millions saved for the use of the banking system.

What has been the effect of this addition of 234 millions to the reserve balances of member banks? The theory of the policy was that the accumulation of excess reserves in the banks would lead to an early expansion of investments and to a gradual easing of lending policies. Moreover, the theory seems well founded not only because loan and investment policies of banks are largely determined by their cash position, but also because in the past our banks have apparently rarely maintained over long periods of time reserves largely in excess of requirements.

Unfortunately, comparable data extending backward into pre-Federal Reserve days are not available for the country as a whole. For New York City, however, excess reserves [1] since 1870 are available. In Chart II they are given for all the major depression periods since that time.

How the accumulation of such excess reserves in 1908 preceded the recovery of that year, and how similar accumulations exerted whatever weight they command on our bank officials in the months prior to the recovery from each of the major depressions of the past sixty years are compared with the recent insignificant accumulations.[2] Evidently, if the policy is to be tested, the pressure will have to be increased and maintained.

Nevertheless, certain important gains have appeared. During the period since February 24, 1932, member-bank borrowings from the Federal Reserve Banks have declined over 300 million dollars. To our banks in their present condition such a reduction in debt cannot but prove a "godsend." The accompanying decline in bank failures during the period of most rapid expansion in turn led to the release of much hoarded cash. More important still at the end of the fourth week of

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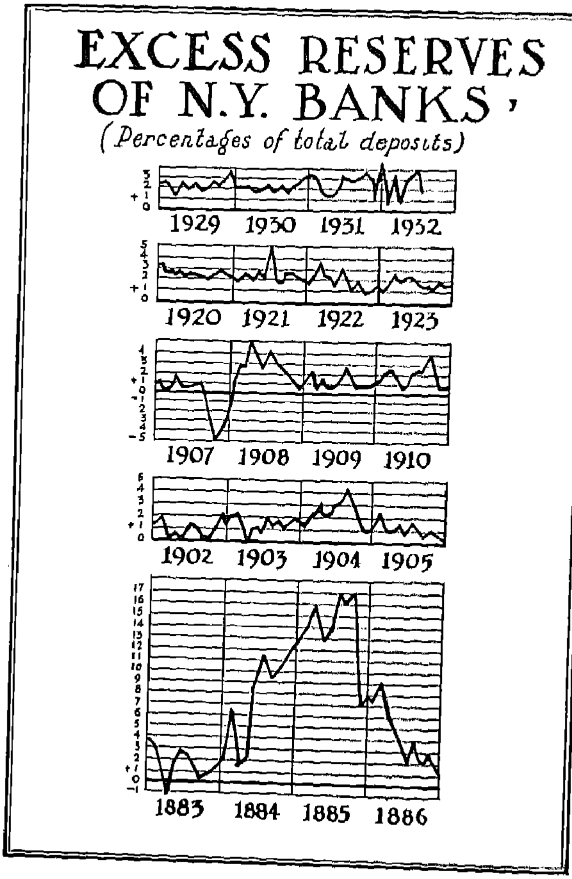
[1] Prior to 1920, data are for New York Clearing House banks; for 1920 and later they are those of New York City reporting member banks. All data include cash in vault.

[2] It is recognized—especially on account of the ready purchase and sale of "Federal funds"—that New York bank excess reserves are far from satisfactory. Since pre-Federal Reserve comparisons are necessary, however, the data seem to be the best available.

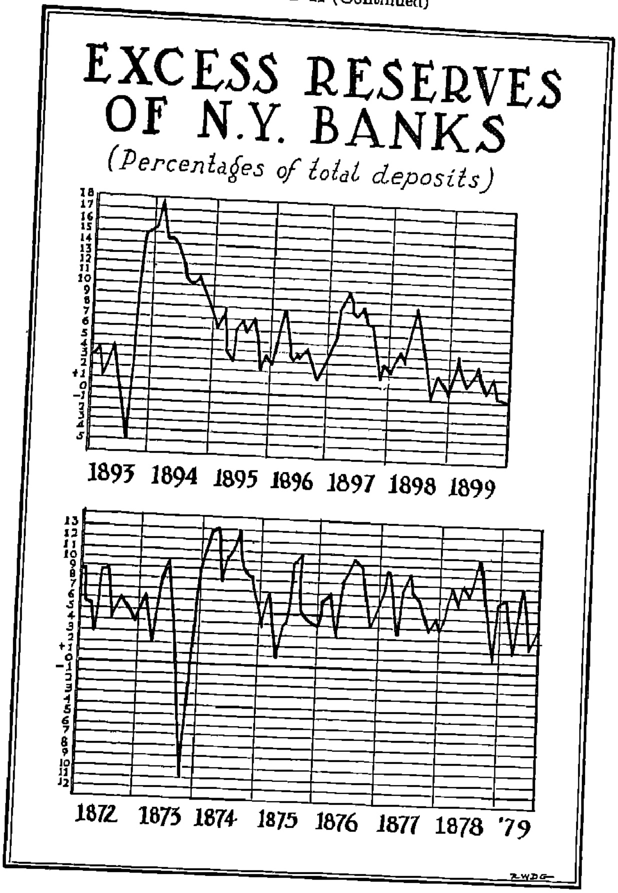
CHART II



the more vigorous policy, liquidation in the reporting member banks had ceased and had actually given place to a net expansion (of 244 million dollars in loans and investments and of 266 millions in deposits). With the big gold outflows that set in immediately afterwards, the liquidation recommenced and has continued unabated until the week ending June 15, when a slight expansion again occurred.

This slight expansion came in the face of a further small decline in member bank reserve balances. Nevertheless, the fact that excess reserves of our banking system are still considerable gives some faint hope that the long-desired turn in liquidation may finally have made its appearance. If the recent gold outflow, greatly accentuated as it was by an American capital flight, is really at an end and if Federal

CHART II (Continued)



Reserve Banks will again maintain their open-market purchases on a level to keep member bank excess reserves gradually mounting, there is some prospect that the policy may yet succeed.

It should be continually borne in mind, however, that until a bond market capable of absorbing a huge amount of refinancing and a reasonable amount of new financing has again made its appearance, the capitalist system can hardly provide the means of economic relief.

If such a bond market cannot be rebuilt by conservative credit expansion, it may soon have to be created with some one or more of the many possible unconservative inflationary measures. The alternative corrective is the continued forced liquidation of a very large amount indeed of still existing debt.

Apparently even the present much-reduced volume of indebtedness is incompatible with the low level of commodity prices. Certainly when combined with the current greatly decreased volume of business, such a price level is hopelessly inadequate. Business must be stimulated, prices raised, or a much greater portion still of our credit structure seems destined to collapse.

AN IMPROVED EQUAL-FREQUENCY MAP OF THE NORMAL CORRELATION SURFACE, USING CIRCLES INSTEAD OF ELLIPSES[1]

By Edward V. Huntington, *Harvard University*

In studying the correlation between two variables X and Y it is often important to compare a given scatter-diagram having observed values of $\bar{X}$, $\bar{Y}$, σ, τ, r, with a normal distribution having the same values of $\bar{X}$, $\bar{Y}$, σ, τ, r. (Here σ and τ denote the standard deviations of the X's and Y's respectively, and r denotes the coefficient of correlation.)

The usual method of making such a comparison is to draw the "50 per cent ellipse" on the diagram, and see whether 50 per cent of the dots lie within the ellipse. But this process is rather laborious, and becomes more so if one attempts to plot the "10 per cent ellipse," the "20 per cent ellipse," etc.

The purpose of this paper is to show how this complicated family of ellipses can be replaced by a simple family of easily plotted concentric circles. These concentric circles, together with a family of equally-spaced radial lines, will form a "cobweb map" which divides the plane into "townships of equal frequency" of any desired fineness of mesh (for example, percentiles, permilles, etc.).

This cobweb map makes possible a direct comparison between the observed distribution of dots and the theoretical distribution in the corresponding normal surface.

HOW THE MAP IS CONSTRUCTED

The process of constructing the map is extremely simple, as follows.

Let Chart I represent the given scatter-diagram, in which h is the class-interval for X, and k the class-interval for Y, and suppose that the means, $\bar{X}$, $\bar{Y}$ (in the original units), the standard deviations, σ, τ (in the original units), and the coefficient of correlation, r (a pure number), have been computed in the usual way. Now redraw the diagram in oblique form, as follows (see Chart II).

First, rotate the axis of Y through an angle ψ given by $\tan\psi = \dfrac{r}{\sqrt{1-r^2}}$.

Second, choose as the geometric unit of length to be used on the

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[1] An abstract of this paper appeared in the *Proceedings of the National Academy of Sciences* for June, 1932.

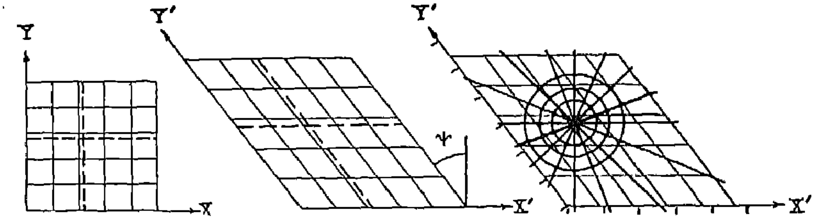

CHART I CHART II CHART III

Note 1. It will be observed that the essential feature of this process is the use of oblique coördinates. If the given diagram is re-drawn in oblique form as in Chart II, then the area around the mean-point $(\bar{X}, \bar{Y})$ can be divided into sectors of equal frequency by simply drawing a family of radial lines at equal angular intervals. A large amount of information can be obtained by counting the dots that lie within these several sectors, without drawing any of the circles. But if a table of K is at hand, much more detailed information can be secured with scarcely any additional labor, by drawing two or three of the circles. In particular, the circle with radius $\pounds(a) = \pounds(u)$ includes about 39 per cent of the total frequency (more precisely, 39.347 per cent); and the circle with radius $\pounds(a) = 3\ \pounds(u)$ includes about 99 per cent (more precisely, 98.889 per cent).

Note 2. The numerical data used in constructing Charts I, II and III, are as follows:

$$h = 100 \text{ oz.},\ \bar{X} = 265 \text{ oz.},\quad \sigma = 110.7 \text{ oz.},$$
$$k = 5 \text{ dol.},\quad \bar{Y} = 15.25 \text{ dol.},\ \tau = 4.75 \text{ dol.};\ r = 0.61.$$

Hence we find $\tan\psi = 0.77$; $\pounds(h) = 1.14\pounds(u)$, $\pounds(k) = 1.33\pounds(u)$; $\pounds(\bar{X}) = 3.02\pounds(u)$, $\pounds(\bar{Y}) = 4.05\pounds(u)$; $\pounds(\sigma) = \pounds(\tau) = 1.26\ \pounds(u)$. The circles shown in Chart III include 25 per cent, 50 per cent, and 75 per cent of the total frequency, respectively.

new diagram a length equal to about $\sqrt{1-r^2} \times \frac{1}{8}$ (the width of the paper), and denote it by $\pounds(u)$. (For example we may have $\pounds(u) = 1$ inch or 1 cm., on the diagram.[1]) Compute the geometric lengths $\pounds(h) = \frac{h}{\sigma}\frac{1}{\sqrt{1-r^2}}\ \pounds(u)$ and $\pounds(k) = \frac{k}{\tau}\frac{1}{\sqrt{1-r^2}}\ \pounds(u)$, to represent on the diagram the class-intervals h and k. Then, laying off successive multiples of $\pounds(h)$ and $\pounds(k)$ along the new axes of X and Y, redraw the given checker-board in the oblique form indicated in Chart II. In the new diagram we shall have $\pounds(\bar{X}) = (\bar{X}/h)\pounds(h)$ and $\pounds(\bar{Y}) = (\bar{Y}/k)\pounds(k)$; and also, incidentally, $\pounds(\sigma) = \pounds(\tau) = \pounds(u)/\sqrt{1-r^2}$.

Third, to find the circle which shall include any given percentage, p, of the total number of dots (where $p = 10$ per cent, 20 per cent, etc.), find the value of the coefficient K given by the formula $K = \sqrt{-2 \log_e(1-p)}$, and compute the geometric length $\pounds(a) = K\pounds(u)$. (A table for K as a function of p is provided.) Then using this geometric length $\pounds(a)$ as radius, and the mean point of Chart II as center, describe a circle. The circle will include the given fraction,

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[1] The notation $\pounds(\sigma)$, which may be read: "*geometric* σ," is introduced in order to keep clear the distinction between a physical magnitude, such as $\sigma = 17$ ounces, and the geometric length which is used to represent this magnitude on the diagram. By the aid of this notation it is possible to adhere strictly to the useful convention that "the equality sign should never be used except between quantities of the same kind." Thus, if $\sigma = 17$ ounces, we may have $\pounds(\sigma) = 2.1$ inches on the diagram, but we could not properly write $\sigma = 2.1$ inches, since 2.1 inches is not equal to 17 ounces. [If, however, u is itself a geometric length on the diagram, then of course $\pounds(u) = u$.]

p, of the total frequency. In this way as many "frequency circles" as desired can be readily constructed.

p (per cent)	10	20	30	40	50	60	70	80	90
K	0.459	0.668	0.845	1.011	1.177	1.354	1.552	1.794	2.146

Fourth, complete the "cobweb" by drawing as many equally-spaced radial lines (see Chart III) as may be desired. (The outermost "townships" extend, of course, to infinity.)

TABLE OF K, FOR USE IN PLOTTING THE MAP OF THE NORMAL SURFACE

$$K=\sqrt{-2\log_e(1-p)}$$

p	K	p	K	p	K	p	K	p	K
.00	.000	.20	.668	.40	1.011	.60	1.354	.80	1.794
.01	.142	.21	.687	.41	1.027	.61	1.372	.81	1.822
.02	.201	.22	.705—	.42	1.044	.62	1.391	.82	1.852
.03	.247	.23	.723	.43	1.060	.63	1.410	.83	1.883
.04	.286	.24	.741	.44	1.077	.64	1.429	.84	1.914
.05	.320	.25	.759	.45	1.093	.65	1.449	.85	1.948
.06	.352	.26	.776	.46	1.110	.66	1.469	.86	1.983
.07	.381	.27	.793	.47	1.127	.67	1.489	.87	2.020
.08	.408	.28	.811	.48	1.144	.68	1.510	.88	2.059
.09	.434	.29	.828	.49	1.161	.69	1.530	.89	2.101
.10	.459	.30	.845—	.50	1.177	.70	1.552	.90	2.146
.11	.483	.31	.861	.51	1.195—	.71	1.573	.91	2.195—
.12	.506	.32	.878	.52	1.212	.72	1.596	.92	2.248
.13	.528	.33	.895—	.53	1.229	.73	1.618	.93	2.306
.14	.549	.34	.911	.54	1.246	.74	1.641	.94	2.372
.15	.570	.35	.928	.55	1.264	.75	1.665+	.95	2.448
.16	.591	.36	.945—	.56	1.282	.76	1.689	.96	2.537
.17	.610	.37	.961	.57	1.300	.77	1.715—	.97	2.648
.18	.630	.38	.978	.58	1.318	.78	1.740	.98	2.797
.19	.649	.39	.994	.59	1.336	.79	1.767	.99	3.035—
								.999	3.717
								.9999	4.292
								.99999	4.799

Inversely,
$p=1-e^{-\frac{1}{2}K^2}$

K	p (per cent)
0.0	0.
0.5	11.75
1.0	39.35
1.5	67.53
2.0	86.47
2.5	95.61
3.0	98.89
3.5	99.78
4.0	99.97

The mapping process here outlined would, it is believed, greatly simplify such applications of statistical theory as Dr. W. A. Shewhart, for example, has found important in Chapter IX of his recent book on *Economic Control of Quality of Manufactured Products.* Also, Professor E. B. Wilson has suggested that the device may be found useful in the study of the random distribution of hits on a target. In general, the process provides a very expeditious graphical method by which the "normality" of any given distribution of two variables may be tested.

PROOF OF THE CORRECTNESS OF THE CONSTRUCTION

The equation of the normal surface, referred to the mean point as origin, is

$$Z=Z_0e^{-f(x,\,y)} \text{ where } f(x,\,y)=\frac{1}{2(1-r^2)}\left[\frac{x^2}{\sigma^2}+\frac{y^2}{\tau^2}-2r\frac{x\,y}{\sigma\,\tau}\right]. \tag{1}$$

Let $x'=\frac{x}{\sigma}\frac{1}{\sqrt{1-r^2}}$, $y'=\frac{y}{\tau}\frac{1}{\sqrt{1-r^2}}$, and $\sin\psi=r$, $\cos\psi=\frac{1}{\sqrt{1-r^2}}$.

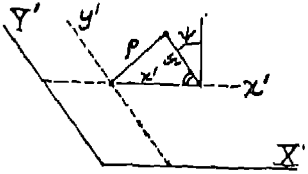
Then if x' and y' are laid off along oblique axes, as in Chart IV, the distance ρ from the origin to the point $(x',\,y')$ is given (in accordance with the law of cosines) by

$$\rho^2=x'^2+y'^2-2\cos(90^\circ-\psi).x'y'=x'^2+y'^2-2rx'y',$$

and the equation of the normal surface reduces to the simple form

$$Z=Z_0e^{-\frac{1}{2}\rho^2}. \tag{2}$$

CHART IV



It should be noted that this process is not the same as an ordinary transformation of coördinates from rectangular to oblique axes, since the surface itself is deformed, as by shearing.

A horizontal section of this deformed surface, at height Z', will be a circle whose radius ρ' is given by $\rho'^2=2(\log_e Z_0-\log_e Z')$.

Let V'=the volume (or frequency) enclosed within this circle. Then V' will consist of a cylinder of altitude Z' plus a dome-shaped cap of altitude Z_0-Z'.

The volume of the cylinder$=\pi\rho'^2Z'=2\pi Z'(\log_e Z_0-\log_e Z')$.

The volume of the dome-shaped cap$=\int_{Z'}^{Z_0}\pi\rho^2dZ=2\pi\int_{Z'}^{Z_0}(\log_e Z_0-\log_e Z)\,dZ=2\pi\log_e Z_0(Z_0-Z')-2\pi(Z_0\log_e Z_0-Z_0)+2\pi(Z'\log_e Z'-Z')=2\pi(Z_0-Z')-2\pi Z'(\log_e Z_0-\log_e Z')$. Hence, by adding these two parts, we have

$$V'=2\pi(Z_0-Z'). \tag{3}$$

But if V = the total volume under the surface, $V=\int_0^\infty Z\cdot 2\pi\rho d\rho = 2\pi Z_0\int_0^\infty e^{-\frac{1}{2}\rho^2}\rho d\rho = 2\pi Z_0$, whence

$$\frac{V'}{V}=1-\frac{Z'}{Z_0}. \qquad (4)$$

Therefore $V'/V=1-s^{-\frac{1}{2}\rho'^2}$, whence

$$\rho'^2=-2\log_e(1-\frac{V'}{V}), \qquad (5)$$

which was to be proved (since $\rho=V'/V$).

A COMPARATIVE STUDY OF THE INDEXES OF PRODUCTION[1]

By Y. S. Leong, *The Brookings Institution*

There are available at the present time several monthly physical volume indexes of producers' goods, of consumers' goods and of general production for the United States, but as yet no comparative study has been made of these measurements with respect to the method of construction, the component series included, the weights employed and the degree of correspondence or difference between them. The present paper attempts to supply this need.

Chart I presents a graphic comparison of the three normal-base indexes of producers' goods: the Harvard "Index of Basic Materials,"[2] Snyder's "Index of Producers' Goods,"[3] and the writer's "Index of Producers' Goods."[4] The close agreement between the movements of these measurements is remarkable. Both Snyder's and the Harvard index are made by the method of taking the weighted arithmetic means of the percentage deviations of certain physical volume series from their computed trends. In both indexes each series is corrected for seasonal variations; in the Harvard index since July, 1922 (the earliest date for which the revised index is available) and in Snyder's index, throughout the period covered, each series is reduced to an average daily basis to make allowance for Sundays and holidays before it is included in the indexes.[5] The writer's index, in contrast, is made by the aggregative method; the corrective factors for the varying number of working days

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[1] The writer is indebted to the Social Science Research Council for the grant of a fellowship which made this study possible, to Dr. C. O. Hardy of the Institute of Economics and Miss Aryness Joy of the Division of Research and Statistics of the Federal Reserve Board for advice and suggestions, and to Mr. R. P. Ward of the Brookings Institution for drawing the charts.

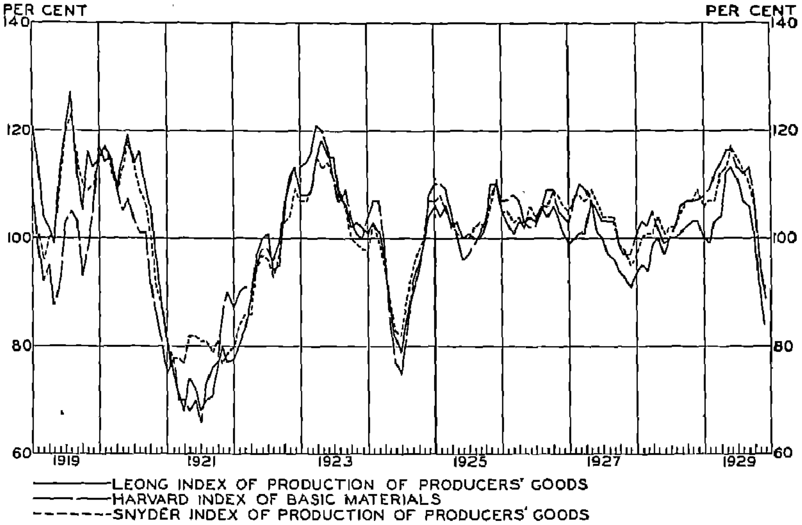
[2] E. E. Day, "Cyclical Fluctuations of the Volume of Manufacture," *Review of Economic Statistics*, January, 1923, p. 30; W. F. Maxwell, "The Revised Index of the Volume of Manufacture," *Ibid.*, May, 1929, p. 68. Other Harvard indexes discussed hereafter are also obtained from these sources.

[3] Snyder's indexes of producers' goods and of consumers' goods, which are two of the components of his Index of the Volume of Trade, have recently been revised for the third time. These indexes, which have not as yet been published, have been kindly furnished to the writer by the Reports Division of the Federal Reserve Bank of New York. See C. Snyder and L. M. Piser, "The Index of the Volume of Trade: Third Revision," this JOURNAL, December, 1931, p. 436. For earlier versions of these indexes, see this JOURNAL, December, 1923, p. 949, September, 1925, p. 397 and June, 1928, p. 154.

[4] Y. S. Leong, "Indexes of the Physical Volume Production of Producers' Goods and Consumers' Goods," this JOURNAL, March, 1932, p. 21. Please refer to this source for the writer's other indexes discussed in this paper.

[5] In making a comparison between the indexes on Chart I it should be noted that the Harvard curve is composed of two sections which are joined together at July, 1922, the earlier section previous to July, 1922, is the unrevised index, the latter since July, 1922, is the revised. The old index apart from the fact that its composition and weights are different is also not corrected for non-working days.

CHART I
COMPARISON OF THE INDEXES OF PRODUCTION OF PRODUCERS' GOODS
Normal=100

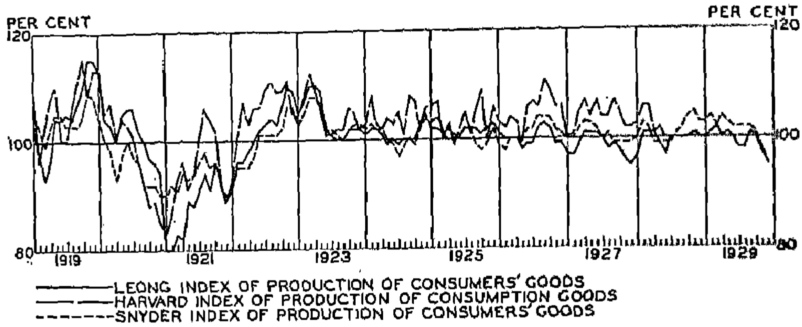


are applied to and the trend and seasonal fluctuations are eliminated from the index only in its final form.

An inspection of Table I will reveal that the scopes of Snyder's and the writer's indexes are broader than that of the Harvard index. Not being represented in the fuel, lumber, non-ferrous metal and transportation equipment groups, which account for 25 and 28 per cent of the weights of Snyder's and the writer's indexes respectively, and assigning relatively little weight to the paper, leather and stone, clay and glass groups, the movement of the Harvard index is in reality largely dominated by two groups: iron and steel and textile, which represent 78 per cent of the weights assigned. The composition of Snyder's and the writer's indexes, except for the inclusion of petroleum and bituminous coal production and agricultural products in the former, is quite similar. With respect to the assignment of weights, however, Snyder's gives relatively less weight to the iron and steel and the lumber groups and relatively greater weight to the textile, fuel and the non-ferrous groups.

In view of the general agreement between the three indexes compared despite the differences in their methods of computation, their composition and their weights, it may be instructive for us to ascertain whether or not by using the same data and applying the identical weights, we may obtain results for Snyder's and for the Harvard indexes on a fixed-base, which will be equally comparable with each other and the writer's

CHART II
COMPARISON OF THE INDEXES OF PRODUCTION OF CONSUMERS' GOODS
Normal=100



differ considerably in their movements. The Harvard index, in contrast to the smoother contour of the other two indexes, is characterized by a large number of "saw-tooth" irregularities, which are to be explained largely by the fact that the former index has not been corrected for the number of Sundays and holidays in each month. Had adjustments for non-working days been made in the Harvard index as they have been in the other two, much of the apparent dissimilarity would have disappeared and the movements between the three indexes would be more closely correlated than they now appear.

Both Snyder's and the Harvard indexes are computed by the familiar weighted averages of relatives-to-trends, while the writer's is by the aggregative method. As may be seen from Table II, the scopes of Snyder's and the writer's indexes are more comprehensive than that of the Harvard. The Harvard index represents five industries, consisting of nine series, of which four are in the food group, to which 60 per cent of the weight is assigned, and two in the tobacco group, to which 14 per cent of the weight is assigned. Inspection of the individual series indicates that all display a relatively slow rate of growth, and as reference to Table IV will show, the trend of the fixed-base composite index, computed with the same data as the normal-base, is negligible, compared to that of the writer's or that of Snyder's. Snyder's index embraces 27 series, covering eight industries, of which the most important is the food group which is assigned over 40 per cent of the total weight. Unlike either of the other two indexes, it includes as components five series of agricultural production with a weight of 14 per cent, and a series of coal production with a weight of 3 per cent. Compared to the writer's index, Snyder's assigns relatively greater weight to the chemical and textile groups and relatively less weight to the printing group. Comparison of Snyder's annual fixed-base index with that of the writ-

TABLE II

COMPARISON OF THE SERIES AND OF THE RELATIVE MAGNITUDE OF THE WEIGHTS ASSIGNED TO EACH SERIES INCLUDED IN THE INDEXES OF CONSUMERS' GOODS COMPUTED BY SNYDER, THE HARVARD SOCIETY AND LEONG

SERIES *	WEIGHTS **		
	Snyder	Harvard Society †	Leong
Food			
Hogs slaughtered	17.0	10.0	9.5
Cattle slaughtered		8.0	6.0
Sheep slaughtered		....	.7
Calves slaughtered		....	.6
Wheat flour produced	7.0	29.0	7.0
Rice shipments	....	....	.3
Sugar meltings	3.0	13.0	3.9
Butter production	....	....	3.7
Cheese production	...	....	.8
Condensed and evaporated milk	.....	....	1.4
Ice cream production	....	....	3.3
Corn grindings	....	....	1.6
Oleomargarine production	....	....	.4
Farm produce shipped	(5) 14.0‡	....	....
Subtotal	(11) 41.0	(4) 60.0	(13) 39.2
Textile			
Carpet and rug loom activity	....	2.0	3.2
Underwear production	1.0	....	4.9
Finished cotton goods	2.0	....	....
Hosiery	2.0	....	....
Men's and boys' suits cut	6.0	....	....
Subtotal	(4) 11.0	(1) 2.0	(2) 8.1
Enameled ware shipment	....	....	(1) 2.5
Printing			
Newsprint consumption	9.0	12.0	12.0
Book paper production	....	....	9.8
Fine paper production	....	....	5.8
Printing activity	5.0	....	....
Subtotal	(2) 14.0	(1) 12.0	(3) 27.6
Rubber			
Pneumatic tire production	6.0	....	5.2
Inner tube production	....	....	.9
Subtotal	(1) 6.0	....	(2) 6.1
Boots and shoes production	(1) 8.0	(1) 12.0	(1) 6.7
Chemical and fuel			
Petroleum products	(4) 12.0§	....	....
Gasolene production	....	....	3.4
Kerosene production	....	....	.5
Anthracite coal production	2.0	....	....
Cottonseed oil production	....	...	1.3
Subtotal	(5) 14.0	....	(3) 5.2
Tobacco			
Cigarettes	6.0	....	2.4
Cigars		11.0	1.4
Tobacco		3.0	.8
Subtotal	(3) 6.0	(2) 14.0	(3) 4.6
Total	(27) 100.0	(9) 100.0	(28) 100.0

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* The figures in parentheses indicate the number of series.

** The weights for the Harvard index are computed from data given by Day, *op. cit.*, p. 54; those for Snyder's are obtained from Snyder and Piser, *op. cit.*, p. 440; and those for the writer's are from Leong, *op. cit.*, p. 36.

† This is known as the Index of Consumption Goods.

‡ The series included under "Farm Produce Shipped" in Snyder's index and their respective weights are as follows: milk receipts, 8; egg receipts, 3; potato shipment, 2; poultry receipts, 1; apple shipments, 1.

§ The series included under "Petroleum Products" in Snyder's index and their respective weights are as follows: gas and fuel oil, 1.1; kerosene, 3.9; gasolene, 9.2; lubricating oil, 10.8.

Series*	Weights**							
	Harvard		F. R. Board		Standard†		Leong	
Metal and metal products								
Copper		....	(1)	2.2‡	(1)	4.0	(1)	2.0
Lead		....	(1)	.6	(1)	1.0	(1)	.6
Zinc		....	(1)	.7	(1)	1.0	(1)	.8
Tin		....	(1)	.5		....	(1)	.5
Subtotal	(0)	....	(4)	4.0	(3)	6.0	(4)	3.9
Tobacco manufactures								
Cigarettes, cigars and tobacco	(3)	8.0	(3)	1.1	(3)	2.0	(3)	1.6
Transportation equipment								
Motor vehicles	(1)	15.5	(1)	6.0	(2)	6.0	(2)	5.6
Railway equipment		....	(1)	.4	(3)	2.0	(2)	.7
Shipbuilding		....	(1)	.3		....	(1)	.2
Subtotal	(1)	15.5	(3)	6.7	(5)	8.0	(5)	6.5
Mineral production								
Bituminous coal		....		....	(1)	2.0		....
Anthracite coal		....		....	(1)	1.0		....
Crude petroleum		....		....	(1)	1.0		....
Subtotal	(0)	....	(0)	....	(3)	4.0	(0)	....
Electric power								
Electric power production		....		....	(1)	3.0		....
Total	(25)	100.0	(52)	100.0	(60)	100.0	(60)	100.0

* The figures in parentheses indicate the number of series.

** The weights for the Harvard index are obtained from Maxwell, *op. cit.*, p. 72; the Federal Reserve Board's are from the *Federal Reserve Bulletin*, February, 1927, p. 103; the Standard's are from the *Standard Statistics Bulletin*, Base Book Issue, 1930-1931, p. 130. Those for the author's are computed from value added data for the years 1923, 1925, and 1927 assigned to each group, industry or series.

† This is known as the Index of Industrial Production.

‡ These series have recently been omitted from the Federal Reserve Board's index.

series which compose the Harvard and the Standard indexes are determined from data, which going many years back of 1919 manifest slower rates of growth for the entire period, for which the data are available, than for the segment of the period since 1919, which is covered by the writer's index. Evidently the secular trend of the writer's index rises at a relatively more rapid rate than the composite trend (a weighted composite of the individual trends computed from the components of the index in question) of either of the other indexes compared,[1] and therefore intersects the writer's curve at points lower at the beginning and higher at the terminal of the period than it would had the rate of increase been less abrupt.

The Harvard adjusted index of manufacturing in its revised form is a composite of 25 series, representing daily average production or machine activity, computed by the method of weighted average of relatives to individual trends. This revised index, however, covers only the period since July, 1922. The curve, as shown on Chart III, is really made up of two indexes, the original index made by Dr. Day being replaced by the revised since July, 1922. The weights of the new index are based on the average of the "net" values added in 1921, 1923 and 1925.[1] Compared to either the writer's index or that of the Standard, the revised index of the Harvard Society is more limited in scope. It is not represented in the lumber, rubber and non-ferrous metal groups; it assigns relatively greater weights to the food, leather, gasolene, tobacco and the automobile industries and relatively less weights to the iron and steel and the textile industries. As shown on Table IV, the annual fixed-base index with the average of 1923–1925 as 100, computed with the identical data and weights which enter into the adjusted index, reveals two striking disagreements: In 1921, it manifests a less severe decline and in 1929 it discloses a higher figure than that shown by any of the annual indexes of manufacture compared. The less pronounced decline in 1921 is largely due to the assignment of relatively heavy weights to those industries, such as food, leather, tobacco, etc., which showed but a mild recession as contrasted with the relatively small weights given to iron and steel, production of which fell precipitantly at this juncture. So too, the higher index number registered in 1929 finds explanation in the allocation of relatively heavy weights to the automobile and the gasolene industries, whose output rose sharply during that year.

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[1] The secular trend of the writer's index gives a rate of growth of 3.9 per cent per year as compared with 2.85 per cent yielded by the Standard weighted composite trend computed from 60 individual lines of growth, from which the percentage deviations composing the adjusted index are taken.

The Standard index of industrial production is essentially an index of manufactures. It differs from the writer's index in that it includes three series of mineral production, to which is assigned a weight of 4 per cent, and one series of electric power, which is given a weight of 2 per cent. These extra series, because of the small weights allotted to them, have not modified the movements of the index from what they would have been had these components been excluded. It is computed by the method of taking the weighted arithmetic means of relatives-to-trends and its weights are derived from the "values added" and "number employed" data as reported in the 1923 Census of Manufactures. It is one of the most comprehensive indexes in current use, containing 60 series, representing practically every industrial group for which current production data are obtainable and covering by months the period since 1910.[2]

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[1] The weights of the early index were based on the values added by manufactures in the census year 1910, but it should be noted that instead of being based on the "net" or actual values added, they were determined by "imputed" values added, that is, in addition to the values added of that series, the values added in the related industries or in later stages of fabrications were also included.

[2] As monthly figures for only a few series go back to 1910, it is necessary to make adjustments in the weights for the discontinued components. Instead of reducing the appropriate weights for the terminated series at the base, they are added to that for iron and steel. Thus the index registers increasingly the production of iron and steel as it goes back to 1910.

TABLE IV

COMPARISON OF ANNUAL INDEXES OF PRODUCTION

1923–1925 = 100

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929
PRODUCERS' GOODS											
Harvard[1][5]	80	94	72	91	106	92	102	105	104	107	113
Snyder[1]	103	90	76	80	102	94	104	108	109	110	117
Leong	90	92	94	87	103	92	105	100	107	111	110
CONSUMERS' GOODS											
Harvard[1][7]	98	93	90	101	101	100	90	101	101	102	104
Snyder[1]	91	80	83	93	90	90	103	100	100	110	113
Leong	83	85	70	92	98	90	103	100	107	112	116
MANUFACTURES											
Harvard[1]	83	84	73	80	101	95	103	107	105	112	122
F. R. Board[2]	84	87	97	80	101	94	105	108	106	112	110
Standard[3][6]	80	84	95	84	102	94	104	107	105	108	115
Leong	84	87	97	88	101	94	105	108	106	112	118
Thomas[4]	82	85	90	86	101	94	105	108	106	112*	110*

[1] Computed by the writer. See footnote [1], *supra* p. 259.

[2] From the *Federal Reserve Bulletin*, March, 1932, p. 159.

[3] From the *Standard Statistical Bulletin*, Base Book Issue, 1930–1931, p. 120. Its original base is the value of the normal for January 1, 1923.

[4] Figures for 1919–1922 are from *Recent Economic Changes*, Vol. II, Table 27, p. 454; original base: 1899=100. Figures for other years are from Miss A. Joy's article. "Index of Production of Manufactures Derived from Census Data—1927," this JOURNAL, December, 1930, p. 457; original base: 1919=100. See text *infra* p. 298.

[5] Known as the Index of Basic Materials.

[6] Known as the Index of Industrial Production.

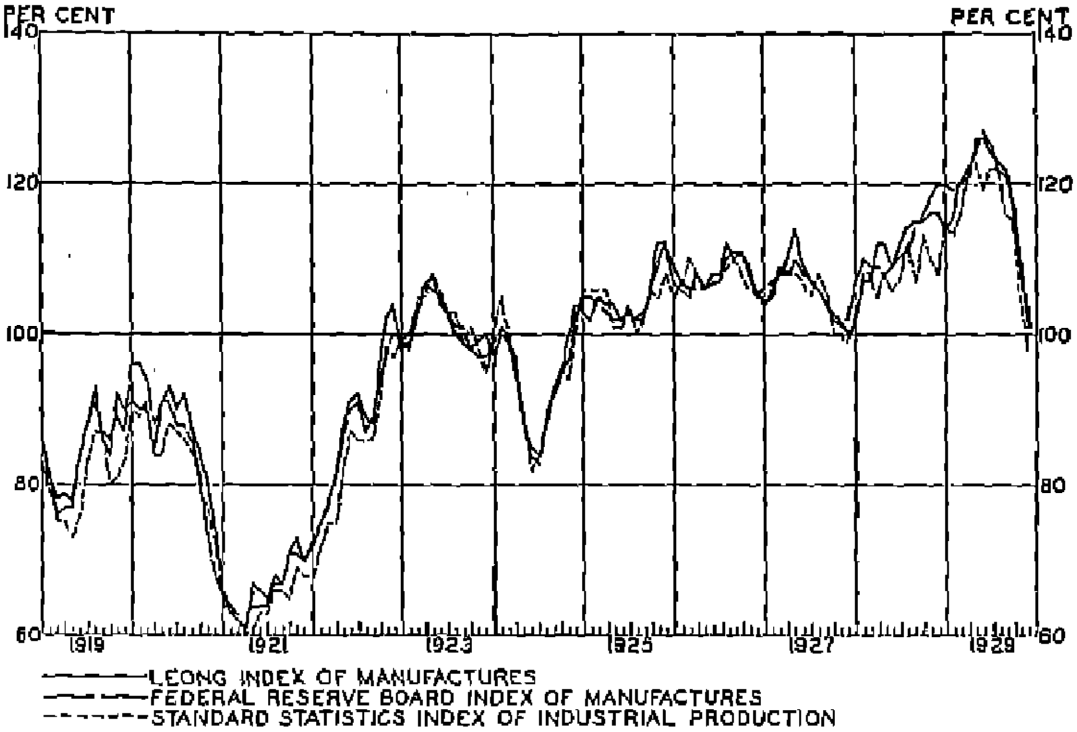
[7] Known as the Index of Consumption Goods.

* Preliminary.

The close correspondence between the three indexes of the production of manufactures on a fixed-base may be observed on Chart IV, on which are presented the Federal Reserve Board's "Index of Manufactures," the Standard Statistics Company's "Index of Industrial Production" and the writer's "Index of Manufactures." The similarity is closer between the writer's index and that of the Federal Reserve Board, but the Standard index would have shown greater agreement with the others had complete adjustments been made to remove the saw-tooth irregularities resulting from the varying number of working days in the different months.

The Standard index, whose base is originally the ordinate of the composite secular trend for January 1, 1923, is not independent of the adjusted index discussed in the previous paragraphs, but is a combination of the adjusted index and the weighted composite index of the computed trends of the constituent series, with the former superimposed on the latter. The computed trends are first reduced to relatives with their respective values for January 1, 1923, equal to 100, and com-

CHART IV
COMPARISON OF THE INDEXES OF PRODUCTION OF MANUFACTURES
1923–1925=100



bined in the same manner and with the identical weight factors, as are the adjusted relatives which compose the normal-base index. Where the trend of a series is absent, as in the case of activity data of textile machinery, that of a component in the same industrial group is substituted, as for instance, cotton spindle activity is represented by the trend for cotton consumption. With the values of the composite trend thus obtained, the fixed-base index may next be derived by multiplying the ordinate of the composite secular trend for the given month by the corresponding adjusted index number and dividing the product by 100.[1]

An index of manufactures on a fixed-base broader in scope and perhaps more scientifically constructed is that of the Federal Reserve Board. This is composed of 49 series,[2] covering practically all industries for which physical output data are promptly obtainable, and representing either directly or indirectly 80 per cent of the total values added by manufacture in 1923. It has not included some of the constituents of the writer's index, such, for example, as butter, cheese, manufactured milk, ice cream, etc., largely because of the tardy publication of these data, which renders impracticable their incorporation in an index which is designed especially for current use. As in the writer's index, the aggregative method is utilized to combine the individual series into a composite, but it should be remarked that in the Board's index each component series is converted into figures representing daily average production for each month and adjusted for seasonal variations before it is incorporated, while in the writer's index the correction for the monthly variations in the number of working days and the adjustment for seasonal variations are made only in the computed composite index. It should also be pointed out that the weight factors of the Board's index are derived from value-added data for 1923 as reported by the Census of Manufactures, while those of the writer's index are based on the value-added figures for 1923, 1925 and 1927. The relative magnitude of the weights assigned is compared in Table III. It is interesting to note there that, while the relative magnitude of the weights assigned to the major industrial groups in the two indexes is much alike, that of the weights allocated to some of the industries and products included in them differ considerably. That the Board's index should agree so closely with the writer's is indeed remarkable in view of the differences in the basis of weighting and in the methods of eliminating the influence of the varying number of working days and of removing the seasonal variations.

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[1] Information concerning the Standard adjusted and unadjusted indexes is obtained from a manuscript entitled: "Standard Index of Industrial Production (Revised)," pp. 1–5, furnished to the writer through the courtesy of the Standard Statistics Company.

[2] Originally the Board's index contained 52 series, but recently three of the component series—flooring, clay products and copper—have been omitted from it.

The accuracy of the three monthly fixed-base indexes graphically shown on Chart IV, may now be gathered from a comparison of the annual fixed-base indexes assembled in Table IV. The most comprehensive and perhaps the most reliable measurement of the production of manufactures for the United States is the biennial index of the Bureau of the Census, constructed by Drs. Day and Thomas, which originally covered the period 1919 to 1925,[1] but which was extended to 1927 by Miss Joy of the Division of Research and Statistics, Federal Reserve Board.[2] This index represents 53 separate industries and includes 137 composite series. The odd-year figures from 1919 to 1927 of the Thomas index are obtained from this source. The intervening even-year figures have been computed by Dr. Thomas, and the figure for 1929 is a preliminary estimate. The correspondence of both the writer's index and the Board's to the Thomas index is surprisingly close. The Standard index, though comparable to the Thomas index, with respect to the rate of growth and the amplitude of the fluctuations, lies on a slightly lower level. This discrepancy is largely to be ascribed to the omission of the shipbuilding series and to the method of weighting the iron and steel series in the Standard index. The shipbuilding industry comprised such an important part of the manufacturing activity in the post war years, that its exclusion from the index would naturally lower the index numbers considerably for those years. In the Census index, as in the Board's and the writer's indexes, the steel ingots series is assigned a weight 10 times that of pig iron, while in the Standard index the two series are given equal weight. Because of the increasing use of scrap iron and steel in the production of steel in recent years, the growth of the production of pig iron has been less rapid than that of steel ingots. In giving pig iron and steel ingots equal weight and in allocating to the iron and steel group a weight of 26 per cent (as compared to 23 in the writer's) the Standard index has a tendency to depress the level of its index numbers, particularly in the terminal years. If the Thomas-Census index may be judged as the most accurate index of the production of manufactures, the close correspondence of the Board's, the Standard and the writer's fixed-base indexes to it, cannot but lead us to the conclusion that these monthly indexes may be trusted to give us fairly reliable measurements of the physical volume production of manufactures.

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[1] E. E. Day and W. Thomas, *The Growth of Manufactures*, Bureau of the Census, 1928, appendices A and C, pp. 93–123, 194–196.

[2] A. Joy, "Index of Production of Manufactures Derived from Census Data—1927," this JOURNAL, December, 1930, p. 453.

A GENERAL METHOD FOR EVALUATING MULTIPLE REGRESSION CONSTANTS

By Paul Horst

Various methods have been presented for calculating partial and multiple coefficients of correlation. Each method purports to offer certain advantages over other methods. However, none of the methods readily available in the journals have presented a general mathematical approach to the problem. The most logical and, from a mathematical point of view, the most obvious method for determining partial and multiple coefficients of correlation involving n variables is one which is based on a few elementary principles of determinants.

It is, however, quite unnecessary for the individual employing the method to be familiar with the theory involved in order to use it effectively. The method which we shall describe enables one to calculate values from which all the standard multiple regression constants may be easily derived by simple algebra. These constants which may be thus evaluated are,

1. The entire set of $\frac{n(n-1)}{2}$ partial coefficients of correlation involving the n variables.
2. All n multiple coefficients of correlation involving the n variables.
3. The entire n sets of $n-1$ regression coefficients involving the n variables.
4. The standard errors of all the regression coefficients. The standard errors of the coefficients of partial and multiple correlation are, of course, simple functions of the coefficients themselves.

To obtain the values from which all of the above constants may be derived by simple algebra requires only about fifty or seventy-five per cent more work than is involved in calculating a set of regression coefficients by the Doolittle method.

We begin with the table of zero order correlation coefficients and write these in the form of a determinant thus,

$$R = \begin{vmatrix} 1 & r_{12} & r_{13} & \cdots & r_{1n} \\ r_{12} & 1 & r_{23} & \cdots & r_{2n} \\ r_{13} & r_{23} & 1 & \cdots & r_{3n} \\ \cdot & \cdot & \cdot & \cdots & \cdot \\ r_{1n} & r_{2n} & r_{3n} & \cdots & 1 \end{vmatrix} \qquad (1)$$

Now we write another determinant called the adjugate determinant of R thus,

$$r' = \begin{vmatrix} R_{11} & R_{12} & \ldots & R_{1n} \\ R_{12} & R_{22} & \ldots & R_{2n} \\ \cdot & \cdot & \cdot & \cdot \\ R_{1n} & R_{2n} & \ldots & R_{nn} \end{vmatrix} \tag{2}$$

in which each element is the cofactor of the corresponding element in R. Since R is symmetrical, r' is also symmetrical, so that $R_{ij} = R_{ji}$.

The elements in r' provide the values from which all the statistical constants enumerated are calculated.

We let

$r_{ij \cdot 12 \ldots () \ldots () \ldots n}$	be any partial coefficient of correlation involving all n variables;
$r_{i \cdot 1 \ldots () \ldots () \ldots n}$	be any multiple coefficient of correlation involving all n variables;
$\beta_{ij \cdot 12 \ldots () \ldots () \ldots n}$	be any regression coefficient involving all n variables in terms of standard measures;
$\sigma_{\beta_{ij \cdot 12 \ldots () \ldots () \ldots n}}$	be the standard error of any regression coefficient involving all n variables given in terms of standard measures.

Then, in general

$$r_{ij \cdot 12 \ldots () \ldots () \ldots n} = \frac{-R_{ij}}{(R_{ii} R_{jj})^{1/2}} \tag{3}$$

$$r_{i \cdot 1 \ldots () \ldots () \ldots n} = \left(1 - \frac{R}{R_{ii}}\right)^{1/2} \tag{4}$$

$$\beta_{ij \cdot 12 \ldots () \ldots () \ldots n} = \frac{R_{ij}}{R_{ii}} \tag{5}$$

$$(N-n)\sigma^2_{\beta_{ij \cdot 12 \ldots () \ldots () \ldots n}} = \frac{R_{ii} R_{jj} - R_{ij}^2}{R_{ii}^2} .* \tag{6}$$

* Here N indicates the number of cases and n the number of variables. The equation (7) taken from Kelley has been modified in that N-n is substituted for N.

The proofs of (3), (4), and (5) are given by Kelley.[1] Kelley uses the minor notation where we use the cofactor notation. The latter notation has the advantage that the signs are taken care of in the definition of a cofactor.

The proof of formula (6) may be readily derived from Kelley's equation,[2]

$$\sigma_{b_{01 \cdot 2 \ldots n}} = \frac{\sigma_{0 \cdot 12 \ldots n}}{\sigma_{1 \cdot 2 \ldots n} \sqrt{N-n}} . \tag{7}$$

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[1] T. L. Kelley, *Statistical Methods*, pp. 295 ff.

[2] *Ibid.*, p. 302, formula 283.

We substitute regression coefficients of standard measures for raw or deviation measures so that

$$\sigma_{0\cdot 12\,\ldots\, n}=\sqrt{1-r^2_{0\cdot 12\,\ldots\, n}} \tag{8}$$

and

$$\sigma_{1\cdot 2\,\ldots\, n}=\sqrt{1-r^2_{1\cdot 2\,\ldots\, n}}. \tag{9}$$

But substituting from (4), equations (8) and (9) become

$$\sigma_{0\cdot 12\,\ldots\, n}=\sqrt{\frac{R}{R_{00}}} \tag{10}$$

$$\sigma_{1\cdot 2\,\ldots\, n}=\sqrt{\frac{R_{00}}{R_{00\,11}}}. \tag{11}$$

Substituting (10) and (11) in (7) and using β instead of b to indicate that the regressions are for standard rather than deviation measures we have

$$\sigma_{\beta_{01\cdot 2\,\ldots\, n}}=\frac{\sqrt{RR_{00\,11}}}{\sqrt{(N-n)R_{00}}}$$

or in general

$$\sigma^2_{\beta_{ij\cdot 12\ldots()\ldots()\ldots n}}=\frac{R\,R_{ii\,jj}}{(N-n)R_{ii}^2}. \tag{12}$$

From an elementary theorem of determinants[1] we know that

$$RR_{ii\,jj}=R_{ii}R_{jj}-R_{ij}^2 \tag{13}$$

so that from (12) and (13) we have

$$\sigma^2_{\beta_{ij\cdot 12\ldots()\ldots()\ldots n}}=\frac{R_{ii}R_{jj}-R_{ij}^2}{(N-n)R_{ii}^2} \tag{14}$$

whence equation (6).

It will be noted that the right hand sides of equations (3), (4), (5) and (6) involve only the elements in r' given by (2). Our problem, then, is to solve for the elements in r'. The procedure for our solution is based on the following considerations. For illustration we shall take the case of four variables. From the elementary theorems of determinants[2] we know that

$$\left.\begin{array}{r}
R_{11}+r_{12}R_{12}+r_{13}R_{13}+r_{14}R_{14}=R\\
r_{12}R_{11}+\quad R_{12}+r_{23}R_{13}+r_{24}R_{14}=0\\
r_{13}R_{11}+r_{23}R_{12}+\quad R_{13}+r_{34}R_{14}=0\\
r_{14}R_{11}+r_{24}R_{12}+r_{34}R_{13}+\quad R_{14}=0
\end{array}\right\} \tag{15}$$

---

[1] M. Bocher, *Introduction to Higher Algebra*, p. 33.

[2] T. Muir and W. H. Metzler, *Theory of Determinants*, pp. 54 and 63.

$$\left.\begin{array}{r} R_{12}+r_{12}R_{22}+r_{13}R_{23}+r_{14}R_{24}=0\\ r_{12}R_{12}+\quad R_{22}+r_{23}R_{23}+r_{24}R_{24}=R\\ r_{13}R_{12}+r_{23}R_{22}+\quad R_{23}+r_{34}R_{24}=0\\ r_{14}R_{12}+r_{24}R_{22}+r_{34}R_{23}+\quad R_{24}=0 \end{array}\right\}\qquad(16)$$

$$\left.\begin{array}{r} R_{13}+r_{12}R_{23}+r_{13}R_{33}+r_{14}R_{34}=0\\ r_{12}R_{13}+\quad R_{23}+r_{23}R_{33}+r_{24}R_{34}=0\\ r_{13}R_{13}+r_{23}R_{23}+\quad R_{33}+r_{34}R_{34}=R\\ r_{14}R_{13}+r_{24}R_{23}+r_{34}R_{33}+\quad R_{34}=0 \end{array}\right\}\qquad(17)$$

$$\left.\begin{array}{r} R_{14}+r_{12}R_{24}+r_{13}R_{34}+r_{14}R_{44}=0\\ r_{12}R_{14}+\quad R_{24}+r_{23}R_{34}+r_{24}R_{44}=0\\ r_{13}R_{14}+r_{23}R_{24}+\quad R_{34}+r_{34}R_{44}=0\\ r_{14}R_{14}+r_{24}R_{24}+r_{34}R_{34}+\quad R_{44}=R \end{array}\right\}\qquad(18)$$

A solution of equations (15) will give the values of all the elements given in the first row of the determinant on the right hand side of equation (2). Solving equations (16), (17), and (18) will give the second, third, and fourth rows respectively of this determinant. Since, however, the coefficients of all four sets of equations are the same, and since $R_{ij}=R_{ji}$, the solutions can be simplified as follows:

We reduce equations (18) by the Doolittle method. It will be remembered that the Doolittle solution gives two sets of reduced equations. The coefficients of the second set are proportional to those of the first set, being obtained by dividing each row of coefficients in the first set by the leading coefficient in that row. We write the first set of reduced equations thus,

$$\left.\begin{array}{r} \gamma_{11}R_{14}+\gamma_{12}R_{24}+\gamma_{13}R_{34}+\gamma_{14}R_{44}=0\\ \gamma_{22}R_{24}+\gamma_{23}R_{34}+\gamma_{24}R_{44}=0\\ \gamma_{33}R_{34}+\gamma_{34}R_{44}=0\\ \gamma_{44}R_{44}=R \end{array}\right\}\qquad(19)$$

For the second set of reduced equations we get

$$\left.\begin{array}{r} -R_{14}+\delta_{12}R_{24}+\delta_{13}R_{34}+\delta_{14}R_{44}=0\\ -R_{24}+\delta_{23}R_{34}+\delta_{24}R_{44}=0\\ -R_{34}+\delta_{34}R_{44}=0\\ -R_{44}=-\dfrac{R}{\gamma_{44}} \end{array}\right\}\qquad(20)$$

where
$$\delta_{ij}=\frac{\gamma_{ij}}{-\gamma_{ii}}.$$

It may be shown[1] that

$$R=\gamma_{11}\gamma_{22}\gamma_{33}\gamma_{44}\qquad(21)$$

---

[1] Paul Horst, "A Short Method for Solving for a Coefficient of Multiple Correlation," *The Annals of Mathematical Statistics*, February, 1932, p. 40. The notation in the present article was adopted in order to be consistent with that used in the reference cited.

hence R may be readily evaluated from the leading coefficients in (10). Transposing, (20) may be written

$$\left.\begin{aligned} R_{14} &= \delta_{12}R_{24}+\delta_{13}R_{34}+\delta_{14}R_{44} \\ R_{24} &= \delta_{23}R_{34}+\delta_{24}R_{44} \\ R_{34} &= \delta_{34}R_{44} \\ R_{44} &= \frac{R}{\gamma_{44}}. \end{aligned}\right\} \qquad (22)$$

Similarly, since the coefficients in (15), (16), and (17) are the same as those in (18), these sets of equations when reduced have the same coefficients as (18). Taking the sets in reverse order, we have for equations (17)

$$\left.\begin{aligned} R_{13} &= \delta_{12}R_{23}+\delta_{13}R_{33}+\delta_{14}R_{34} \\ R_{23} &= \delta_{23}R_{33}+\delta_{24}R_{34} \\ R_{33} &= \delta_{34}R_{34}+\frac{R}{\gamma_{33}} \end{aligned}\right\} \qquad (23)$$

omitting the last equation. This equation involves only R_{34} which is solved for from equations (22). Similarly, we omit the last two equations in the reduction of equations (16), writing these

$$\left.\begin{aligned} R_{12} &= \delta_{12}R_{22}+\delta_{13}R_{23}+\delta_{14}R_{24} \\ R_{22} &= \delta_{23}R_{23}+\delta_{24}R_{24}+\frac{R}{\gamma_{22}}. \end{aligned}\right\} \qquad (24)$$

For equations (15) we need only the first of the reduced equations, viz.,

$$R_{11}=\delta_{12}R_{12}+\delta_{13}R_{13}+\delta_{14}R_{14}+\frac{R}{\gamma_{11}}. \qquad (25)$$

Obviously, since $\gamma_{11}=1$ the δ's in (25) are merely the negatives of the r_{1i}'s, so that (25) might be written in the familiar form

$$R_{11}+r_{12}R_{12}+r_{13}R_{13}+r_{14}R_{14}=R$$

which is, of course, the expansion of the determinant by the first row. The form (25) is given merely to keep the notation uniform with that of equations (22), (23) and (24).

Equations (22), (23), (24) and (25) enable us to solve for all the elements of the determinant in equation (2). These elements provide the values from which all the statistical constants given by equations (3), (4), (5) and (6) may be calculated.

Perhaps the greatest advantage of the above outlined method is the ease with which standard errors of regression coefficients may be calculated from formula (6).

If the work sheets are systematically drawn up the solutions are perfectly straightforward. The R_{ij}-values may be listed in a table corresponding to the determinant r' given by (2). It is a simple matter to select the required values from this table and to solve for any particular constants given by (3), (4), (5) and (6).

To illustrate the method outlined above the work sheets for a 7-variable problem are given.

Form A is merely the table of zero order correlation coefficients. These are taken as the coefficients of the normal equations. The Doolittle method must be employed for the forward solution rather than any approximation or iteration method. The variables must be arranged so that the dependent or criterion variable is the n'th variable.

The arrangement of the work sheets, however, is somewhat different than is usually described for a Doolittle reduction. This arrangement makes for convenience and economy in the calculation of the R_{ij}-values.

Form B is divided into as many sections as there are variables. In the first line of each section is copied the corresponding line from Form A. Each line in Form C gives the column summations of the corresponding section in Form B. Form C gives the coefficients of the first set of reduced equations.

Form D gives the coefficients of the second set of reduced equations, and is obtained by multiplying each line in Form C by the negative reciprocal of its leading coefficient. These negative reciprocals are written to the left of the coefficients in Form C.

It is convenient to have Forms C and D separate, since Form D gives only the values required for the back solutions. Furthermore, by matching corresponding columns of the two forms, an entire line may be calculated for the corresponding section of Form B, retaining a constant multiplier in the calculating machine.

It is best to use the values in Form D as the constant multipliers, folding the sheet after each column, as the folds are again employed in the back solutions.

A summation check column is carried as in the usual Doolittle solution.

The value at the bottom of the S-column in Form C is not a check but rather the cumulative product of all the diagonal terms on this form, and gives the value R of the determinant of the zero order correlation coefficients. (See equation (21).)

Form E gives the back solutions for the R_{ij}-values. The horizontal summations, however, instead of being carried at the right of the successive sections are recorded on Form F. Each column in Form F is a horizontal summation of the corresponding section on Form E. With the back solution work laid out in this manner an entire column may be

Form A - Zero Order Correlation Coefficients

	1	2	3	4	5	6	7
1	1.	.708	.128	.383	-.283	.412	.416
2		1.	.079	.241	-.219	.650	.250
3			1.	.078	.032	.280	.108
4				1.	-.281	-.004	.643
5					1.	.111	-.210
6						1.	.063
7							1.

Form B - Calculations for the Reduced Equations

	1	2	3	4	5	6	7	S
1	1.	+.70800	+.12800	+.38300	-.28300	+.41200	+.41600	+2.76400
2		1.	+.07900	+.24100	-.21900	+.65000	+.25000	+2.70900
	- 2	-.50126	-.09062	-.27116	+.20036	-.29170	-.29452	-1.95691
3			1.	+.07800	+.03200	+.28000	+.10800	+1.70500
		2	-.01638	-.04902	+.03622	-.05274	-.05325	- .35379
		3	-.00027	-.00070	-.00043	+.00835	-.00104	+ .01752
4				1.	-.28100	-.00400	+.64300	+2.06000
			2	-.14669	+.10839	-.15780	-.15933	-1.05861
			3	-.00182	-.00113	+.02167	-.00269	+ .04548
			4	-.00081	-.00196	-.00678	-.00154	- .03936
5					1.	+.11100	-.21000	+ .15000
				2	-.08009	+.11660	+.11773	+ .78221
				3	-.00070	+.01339	-.00166	+ .02811
				4	-.00467	-.01624	-.00370	- .09436
				5	-.03629	-.03034	+.09902	+ .20808
6						1.	+.06300	+2.51200
					2	-.16974	-.17139	-1.13877
					3	-.25741	+.03199	- .54031
					4	-.05645	-.01287	- .32795
					5	-.02537	+.08280	+ .17400
					6	-.04303	-.00031	- .23776
7							1.	+2.27000
						2	-.17306	-1.14982
						3	-.00399	+ .06715
						4	-.00293	- .07476
						5	-.27021	- .56783
						6	-.00000	- .00170
						7	-.00010	+ .00668

Form C - First Set of Reduced Equations or γ-Coefficients

	1	2	3	4	5	6	7	S
1	+1.00000	+ .70800	+ .12800	+ .38300	- .28300	+ .41200	+ .41600	+2.76400
2	-2.005062	+ .49874	- .01162	- .03016	- .01864	+ .35830	- .04463	+ .75209
3		-1.016931	+ .98335	+ .02828	+ .06779	+ .23561	+ .05371	+1.36873
4			-1.175530	+ .85068	- .17569	- .14691	+ .47944	+1.00751
5				-1.138627	+ .87826	+ .19441	+ .00139	+1.07404
6					-2.232142	+ .44800	- .00678	+ .44122
7						-1.819107	+ .54972	+ .54972
							R =	.09024

Form D - Second Set of Reduced Equations or δ-Coefficients

	1	2	3	4	5	6	7	S
1	-1.00000	- .70800	- .12800	- .38300	+ .28300	- .41200	- .41600	-2.76400
2		-1.00000	+ .02330	+ .06047	+ .03737	- .71841	+ .08948	-1.50798
3			-1.00000	- .02876	- .06894	- .23960	- .05462	-1.39190
4				-1.00000	+ .20653	+ .17270	- .56360	-1.18436
5					-1.00000	- .22136	- .00158	-1.22293
6						-1.00000	+ .01513	- .98487
7							-1.00000	-1.00000

calculated by putting the appropriate R_{ij} in the calculating machine and multiplying the corresponding column on Form D by it.

Obviously, any R_{ij} will always be calculated from a horizontal sum-

Form E - Back Solutions for the R_{ij} - Values

7	$\delta_{i2}R_{27}$	$\delta_{i3}R_{37}$	$\delta_{i4}R_{47}$	$\delta_{i5}R_{57}$	$\delta_{i6}R_{67}$	$\delta_{i7}R_{77}$	$R \div \gamma_{77}$
R_{17} =	-.00603	+.00088	+.03634	-.00023	-.00102	-.06829	
	R_{27} =	-.00016	-.00558	-.00003	-.00178	+.01466	
		R_{37} =	+.00265	+.00006	-.00059	-.00897	
			R_{47} =	-.00017	+.00043	-.09252	
				R_{57} =	-.00055	-.00026	
					R_{67} =	+.00248	
						R_{77}	+.16416

6	$\delta_{i2}R_{26}$	$\delta_{i3}R_{36}$	$\delta_{i4}R_{46}$	$\delta_{i5}R_{56}$	$\delta_{i6}R_{66}$	$\delta_{i7}R_{67}$	$R \div \gamma_{66}$
R_{16} =	+.10623	+.00589	-.00926	-.01262	-.08301	-.00103	
	R_{26} =	-.00107	+.00146	-.00167	-.14474	+.00022	
		R_{36} =	-.00070	+.00307	-.04827	-.00014	
			R_{46} =	-.00921	+.03479	-.00140	
				R_{56} =	-.04460	-.00000	
					R_{66} =	+.00004	+.20143

5	$\delta_{i2}R_{25}$	$\delta_{i3}R_{35}$	$\delta_{i4}R_{45}$	$\delta_{i5}R_{55}$	$\delta_{i6}R_{56}$	$\delta_{i7}R_{57}$	$R \div \gamma_{55}$
R_{15} =	-.02634	-.00032	-.00614	+.03187	+.01638	+.00034	
	R_{25} =	+.00006	+.00097	+.00421	+.03204	-.00007	
		R_{35} =	-.00046	-.00776	+.01069	+.00004	
			R_{45} =	+.02326	-.00770	+.00046	
				R_{55} =	+.00987	+.00000	+.10275

4	$\delta_{i2}R_{24}$	$\delta_{i3}R_{34}$	$\delta_{i4}R_{44}$	$\delta_{i5}R_{45}$	$\delta_{i6}R_{46}$	$\delta_{i7}R_{47}$	$R \div \gamma_{44}$
R_{14} =	+.01073	+.00085	-.06341	+.00463	-.00996	+.03838	
	R_{24} =	-.00015	+.01001	+.00060	-.01737	-.00824	
		R_{34} =	-.00476	-.00110	-.00679	+.00504	
			R_{44} =	+.00331	+.00418	+.06200	+.10608

3	$\delta_{i2}R_{23}$	$\delta_{i3}R_{33}$	$\delta_{i4}R_{34}$	$\delta_{i5}R_{35}$	$\delta_{i6}R_{36}$	$\delta_{i7}R_{37}$	$R \div \gamma_{33}$
R_{13} =	-.02447	-.01321	+.00253	+.00071	+.01897	+.00285	
	R_{23} =	+.00240	-.00040	+.00009	+.03308	-.00061	
		R_{33} =	+.00019	-.00017	+.01103	+.00037	+.09177

2	$\delta_{i2}R_{22}$	$\delta_{i3}R_{23}$	$\delta_{i4}R_{24}$	$\delta_{i5}R_{25}$	$\delta_{i6}R_{26}$	$\delta_{i7}R_{27}$	$R \div \gamma_{22}$
R_{12} =	-.20361	-.00442	+.00680	+.01053	+.06007	-.00296	
	R_{22} =	+.00081	-.00092	+.00139	+.10474	+.00068	+.18094

1	$\delta_{i2}R_{12}$	$\delta_{i3}R_{13}$	$\delta_{i4}R_{14}$	$\delta_{i5}R_{15}$	$\delta_{i6}R_{16}$	$\delta_{i7}R_{17}$	$R \div \gamma_{11}$
R_{11} =	+.09529	+.00162	+.00723	+.00603	-.00132	+.01595	+.09024

Form F - Table of R_{ij}'s

	1	2	3	4	5	6	7
1	+.21404	-.13459	-.01262	-.01888	+.01779	+.00320	-.03835
2		+.28769	+.03466	-.01515	+.03721	-.14680	+.00711
3			+.10319	-.00661	+.00261	-.04604	-.00685
4				+.16557	+.01602	+.02418	-.09226
5					+.11262	-.04460	-.00081
6						+.20147	+.00248
7							+.16416

Form G - Check Sheet for the R_{ij}'s

	1	2	3	4	5	6	7	
1	+.21404	-.09529	-.00162	-.00723	-.00603	+.00132	-.01595	.09024
2		+.28759	+.00273	-.00365	-.00815	-.09477	+.00178	.09024
3			+.10319	-.00052	+.00008	-.01289	-.00074	.09023
4				+.16557	-.00450	-.00010	-.05932	.09024
5					+.11262	-.00495	+.00017	.09024
6						+.20147	+.00016	.09024
7							+.16416	.09025

mation just before it is required as a multiplier for the next column to the left.

For each section in Form E, the columns to the right of the double ruling are obtained by using those R_{ij}-values which were evaluated in the preceding section as multipliers for the corresponding columns in Form D. This is made clear by the column headings of the respective sections in Form E.

As each column in Form F is completed it is matched with the corresponding column in Form A and the products written in the corresponding column of Form G in order to check the R_{ij}-values. As each column in Form G is completed its sum plus the sum of the line to the right of its last term is evaluated and this total entered on the same line in the R-column at the right. This total should equal the cumulative product of the diagonal terms in Form C. This, of course, is the sum of the products of the zero order correlation coefficients in a given row of the determinant by their respective cofactors. The number of variables and the number of decimal places carried will determine how closely the values will check.

The method outlined gives a clean cut solution for the R_{ij}-values, and requires no re-copying of figures or unnecessary duplication of machine work. Form G provides an algebraic check on each set of back solution calculations.

For comparative purposes it may be noted that the ordinary Doolittle solution for regression coefficients carries us through Forms A, B, C, and D; and through section 7 of Form E, and column 7 of Form F.

The solution carried this far provides data for only the one multiple correlation coefficient and the $n-1$ regression coefficients. From equations (3) and (6) it is clear that it does not provide sufficient data for the calculation of any partial coefficients of correlation or standard errors of the regression coefficients.

In order to calculate all partial correlation coefficients involving the n'th variable and all standard errors of the regression coefficients involving the n'th variable, equations (3) and (6) show that it is necessary to carry the solution through the entire series of back solutions. This is necessary because all the R_{ii}-values are required in the calculation of these constants, and to get all the R_{ii}-values all the R_{ij}-values must be calculated.

However, the additional labor is little more than fifty per cent of that required for the solution of the regression coefficients alone, and when the entire table of R_{ij}-values is calculated any variable may be taken for the dependent variable, and the entire series of constants given by equations (3), (4), (5) and (6) calculated for this variable.

ADAPTATION OF NEW GEOMETRIC CODE TO MULTIPLE PUNCHING IN MECHANICAL TABULATION

By Halbert L. Dunn, *The Mayo Clinic*

The 45 and 80 column mechanical punch cards sold by both the International Business Machines Company and Powers Tabulating Machines Company, have a capacity which is too limited for many problems to which they are applied. Experience proves that secondary cards are unsatisfactory since they add to tabulating time, particularly if variables on a secondary card are being correlated with items of information on a primary card.

The geometric code which I have devised, has proved in actual use at The Mayo Clinic, to be the best method of obtaining maximal capacity of the card.

The entire cross index plan in use at The Mayo Clinic, involving all diagnostic, surgical, therapeutic and financial factors, approximately 150 items concerning each patient, has been placed on a single punch card. Each item has many variables. This number of facts would have been impossible to record, without the use, for the majority of them of a geometric code. Although this device is concerned with great detail, more than 100,000 primary cards, and more than 500,000 secondary cards can be handled in a year, and with less cost than otherwise. With use of codes which involve only a single punch per column, more than twenty cards would be required for record of the material that by use of the geometric code, can be placed on a single card.

On the punch card, as furnished, each column has ten positions, reading from above downward, from zero to 9. For use with the geometric code the two other positions, above the zero, are known as *y* and *x*. Thus, the column reads, from above downward, *y*, *x*, zero, 1, 2 and so on down to 9. This allows all combinations from 1 to 12 to be used, and if these 12 combinations are used to represent a geometric progression beginning opposite 1 at the bottom of 9 position, the positions in a given column could be represented as follows, which would be the maximal capacity of the column:

Position	*Number in the geometric progression*
y	2,048
x	1,024
0	512
1	256

GEOMETRIC CODES

NOTE.—The highest or number twelve position in the punch card column is indicated as y in the geometric code and the next highest or eleventh position as x. There are ten geometric codes each of which is indicated by the punch card position number. The lowest position number in each code is one and must be punched for all odd numbers, together with the code for the preceding even number. Punch cards using this code can be arranged in order in the following manner: (a) sort with all boxes open, (b) block out the box corresponding to the lowest position in the code used and run cards in this box again, permitting all other cards to remain as they were sorted in their respective boxes, (c) block out successively higher boxes corresponding to the next higher punch card position, each time re-running the cards from the box which has been blocked out until all cards fall in the box corresponding to the highest position used.

Position (y-9)		3	2	2 3	1	1 3	1 2	1 2 3	0	0 3	0 2	0 2 3	0 1	0 1 3	0 1 2	0 1 2 3	x	x 3	x 2	x 2 3	x 1	x 1 3	x 1 2	x 1 2 3	x 0	x 0 3	x 0 2	x 0 2 3	x 0 1	x 0 1 3	x 0 1 2	x 0 1 2 3
	0	64	128	192	256	320	384	448	512	576	640	704	768	832	896	960	1024	1088	1152	1216	1280	1344	1408	1472	1536	1600	1664	1728	1792	1856	1920	1984
8	2	66	130	194	258	322	386	450	514	578	642	706	770	834	898	962	1026	1090	1154	1218	1282	1346	1410	1474	1538	1602	1666	1730	1794	1858	1922	1986
7	4	68	132	196	260	324	388	452	516	580	644	708	772	836	900	964	1028	1092	1156	1220	1284	1348	1412	1476	1540	1604	1668	1732	1796	1860	1924	1988
8 7	6	70	134	198	262	326	390	454	518	582	646	710	774	838	902	966	1030	1094	1158	1222	1286	1350	1414	1478	1542	1606	1670	1734	1798	1862	1926	1990
6	8	72	136	200	264	328	392	456	520	584	648	712	776	840	904	968	1032	1096	1160	1224	1288	1352	1416	1480	1544	1608	1672	1736	1800	1864	1928	1992
8 6	10	74	138	202	266	330	394	458	522	586	650	714	778	842	906	970	1034	1098	1162	1226	1290	1354	1418	1482	1546	1610	1674	1738	1802	1866	1930	1994
7 6	12	76	140	204	268	332	396	460	524	588	652	716	780	844	908	972	1036	1100	1164	1228	1292	1356	1420	1484	1548	1612	1676	1740	1804	1868	1932	1996
8 7 6	14	78	142	206	270	334	398	462	526	590	654	718	782	846	910	974	1038	1102	1166	1230	1294	1358	1422	1486	1550	1614	1678	1742	1806	1870	1934	1998
5	16	80	144	208	272	336	400	464	528	592	656	720	784	848	912	976	1040	1104	1168	1232	1296	1360	1424	1488	1552	1616	1680	1744	1808	1872	1936	2000
8 5	18	82	146	210	274	338	402	466	530	594	658	722	786	850	914	978	1042	1106	1170	1234	1298	1362	1426	1490	1554	1618	1682	1746	1810	1874	1938	2002
7 5	20	84	148	212	276	340	404	468	532	596	660	724	788	852	916	980	1044	1108	1172	1236	1300	1364	1428	1492	1556	1620	1684	1748	1812	1876	1940	2004
8 7 5	22	86	150	214	278	342	406	470	534	598	662	726	790	854	918	982	1046	1110	1174	1238	1302	1366	1430	1494	1558	1622	1686	1750	1814	1878	1942	2006
6 5	24	88	152	216	280	344	408	472	536	600	664	728	792	856	920	984	1048	1112	1176	1240	1304	1368	1432	1496	1560	1624	1688	1752	1816	1880	1944	2008
8 6 5	26	90	154	218	282	346	410	474	538	602	666	730	794	858	922	986	1050	1114	1178	1242	1306	1370	1434	1498	1562	1626	1690	1754	1818	1882	1946	2010
7 6 5	28	92	156	220	284	348	412	476	540	604	668	732	796	860	924	988	1052	1116	1180	1244	1308	1372	1436	1500	1564	1628	1692	1756	1820	1884	1948	2012
8 7 6 5	30	94	158	222	286	350	414	478	542	606	670	734	798	862	926	990	1054	1118	1182	1246	1310	1374	1438	1502	1566	1630	1694	1758	1822	1886	1950	2014
4	32	96	160	224	288	352	416	480	544	608	672	736	800	864	928	992	1056	1120	1184	1248	1312	1376	1440	1504	1568	1632	1696	1760	1824	1888	1952	2016
8 4	34	98	162	226	290	354	418	482	546	610	674	738	802	866	930	994	1058	1122	1186	1250	1314	1378	1442	1506	1570	1634	1698	1762	1826	1890	1954	2018
7 4	36	100	164	228	292	356	420	484	548	612	676	740	804	868	932	996	1060	1124	1188	1252	1316	1380	1444	1508	1572	1636	1700	1764	1828	1892	1956	2020
8 7 4	38	102	166	230	294	358	422	486	550	614	678	742	806	870	934	998	1062	1126	1190	1254	1318	1382	1446	1510	1574	1638	1702	1766	1830	1894	1958	2022
6 4	40	104	168	232	296	360	424	488	552	616	680	744	808	872	936	1000	1064	1128	1192	1256	1320	1384	1448	1512	1576	1640	1704	1768	1832	1896	1960	2024
8 6 4	42	106	170	234	298	362	426	490	554	618	682	746	810	874	938	1002	1066	1130	1194	1258	1322	1386	1450	1514	1578	1642	1706	1770	1834	1898	1962	2026
7 6 4	44	108	172	236	300	364	428	492	556	620	684	748	812	876	940	1004	1068	1132	1196	1260	1324	1388	1452	1516	1580	1644	1708	1772	1836	1900	1964	2028
8 7 6 4	46	110	174	238	302	366	430	494	558	622	686	750	814	878	942	1006	1070	1134	1198	1262	1326	1390	1454	1518	1582	1646	1710	1774	1838	1902	1966	2030
5 4	48	112	176	240	304	368	432	496	560	624	688	752	816	880	944	1008	1072	1136	1200	1264	1328	1392	1456	1520	1584	1648	1712	1776	1840	1904	1968	2032
8 5 4	50	114	178	242	306	370	434	498	562	626	690	754	818	882	946	1010	1074	1138	1202	1266	1330	1394	1458	1522	1586	1650	1714	1778	1842	1906	1970	2034
7 5 4	52	116	180	244	308	372	436	500	564	628	692	756	820	884	948	1012	1076	1140	1204	1268	1332	1396	1460	1524	1588	1652	1716	1780	1844	1908	1972	2036
8 7 5 4	54	118	182	246	310	374	438	502	566	630	694	758	822	886	950	1014	1078	1142	1206	1270	1334	1398	1462	1526	1590	1654	1718	1782	1846	1910	1974	2038
6 5 4	56	120	184	248	312	376	440	504	568	632	696	760	824	888	952	1016	1080	1144	1208	1272	1336	1400	1464	1528	1592	1656	1720	1784	1848	1912	1976	2040
8 6 5 4	58	122	186	250	314	378	442	506	570	634	698	762	826	890	954	1018	1082	1146	1210	1274	1338	1402	1466	1530	1594	1658	1722	1786	1850	1914	1978	2042
7 6 5 4	60	124	188	252	316	380	444	508	572	636	700	764	828	892	956	1020	1084	1148	1212	1276	1340	1404	1468	1532	1596	1660	1724	1788	1852	1916	1980	2044
8 7 6 5 4	62	126	190	254	318	382	446	510	574	638	702	766	830	894	958	1022	1086	1150	1214	1278	1342	1406	1470	1534	1598	1662	1726	1790	1854	1918	1982	2046

Position (y-9)	y	y 3	y 2	y 2 3	y 1	y 1 3	y 1 2	y 1 2 3	y 0	y 0 3	y 0 2	y 0 2 3	y 0 1	y 0 1 3	y 0 1 2	y 0 1 2 3	y x	y x 3	y x 2	y x 2 3	y x 1	y x 1 3	y x 1 2	y x 1 2 3	y x 0	y x 0 3	y x 0 2	y x 0 2 3	y x 0 1	y x 0 1 3	y x 0 1 2	y x 0 1 2 3
	2048	2112	2176	2240	2304	2368	2432	2496	2560	2624	2688	2752	2816	2880	2944	3008	3072	3136	3200	3264	3328	3392	3456	3520	3584	3648	3712	3776	3840	3904	3968	4032
8	2050	2114	2178	2242	2306	2370	2434	2498	2562	2626	2690	2754	2818	2882	2946	3010	3074	3138	3202	3266	3330	3394	3458	3522	3586	3650	3714	3778	3842	3906	3970	4034
7	2052	2116	2180	2244	2308	2372	2436	2500	2564	2628	2692	2756	2820	2884	2948	3012	3076	3140	3204	3268	3332	3396	3460	3524	3588	3652	3716	3780	3844	3908	3972	4036
8 7	2054	2118	2182	2246	2310	2374	2438	2502	2566	2630	2694	2758	2822	2886	2950	3014	3078	3142	3206	3270	3334	3398	3462	3526	3590	3654	3718	3782	3846	3910	3974	4038
6	2056	2120	2184	2248	2312	2376	2440	2504	2568	2632	2696	2760	2824	2888	2952	3016	3080	3144	3208	3272	3336	3400	3464	3528	3592	3656	3720	3784	3848	3912	3976	4040
8 6	2058	2122	2186	2250	2314	2378	2442	2506	2570	2634	2698	2762	2826	2890	2954	3018	3082	3146	3210	3274	3338	3402	3466	3530	3594	3658	3722	3786	3850	3914	3978	4042
7 6	2060	2124	2188	2252	2316	2380	2444	2508	2572	2636	2700	2764	2828	2892	2956	3020	3084	3148	3212	3276	3340	3404	3468	3532	3596	3660	3724	3788	3852	3916	3980	4044
8 7 6	2062	2126	2190	2254	2318	2382	2446	2510	2574	2638	2702	2766	2830	2894	2958	3022	3086	3150	3214	3278	3342	3406	3470	3534	3598	3662	3726	3790	3854	3918	3982	4046
5	2064	2128	2192	2256	2320	2384	2448	2512	2576	2640	2704	2768	2832	2896	2960	3024	3088	3152	3216	3280	3344	3408	3472	3536	3600	3664	3728	3792	3856	3920	3984	4048
8 5	2066	2130	2194	2258	2322	2386	2450	2514	2578	2642	2706	2770	2834	2898	2962	3026	3090	3154	3218	3282	3346	3410	3474	3538	3602	3666	3730	3794	3858	3922	3986	4050
7 5	2068	2132	2196	2260	2324	2388	2452	2516	2580	2644	2708	2772	2836	2900	2964	3028	3092	3156	3220	3284	3348	3412	3476	3540	3604	3668	3732	3796	3860	3924	3988	4052
8 7 5	2070	2134	2198	2262	2326	2390	2454	2518	2582	2646	2710	2774	2838	2902	2966	3030	3094	3158	3222	3286	3350	3414	3478	3542	3606	3670	3734	3798	3862	3926	3990	4054
6 5	2072	2136	2200	2264	2328	2392	2456	2520	2584	2648	2712	2776	2840	2904	2968	3032	3096	3160	3224	3288	3352	3416	3480	3544	3608	3672	3736	3800	3864	3928	3992	4056
8 6 5	2074	2138	2202	2266	2330	2394	2458	2522	2586	2650	2714	2778	2842	2906	2970	3034	3098	3162	3226	3290	3354	3418	3482	3546	3610	3674	3738	3802	3866	3930	3994	4058
7 6 5	2076	2140	2204	2268	2332	2396	2460	2524	2588	2652	2716	2780	2844	2908	2972	3036	3100	3164	3228	3292	3356	3420	3484	3548	3612	3676	3740	3804	3868	3932	3996	4060
8 7 6 5	2078	2142	2206	2270	2334	2398	2462	2526	2590	2654	2718	2782	2846	2910	2974	3038	3102	3166	3230	3294	3358	3422	3486	3550	3614	3678	3742	3806	3870	3934	3998	4062
4	2080	2144	2208	2272	2336	2400	2464	2528	2592	2656	2720	2784	2848	2912	2976	3040	3104	3168	3232	3296	3360	3424	3488	3552	3616	3680	3744	3808	3872	3936	4000	4064
8 4	2082	2146	2210	2274	2338	2402	2466	2530	2594	2658	2722	2786	2850	2914	2978	3042	3106	3170	3234	3298	3362	3426	3490	3554	3618	3682	3746	3810	3874	3938	4002	4066
7 4	2084	2148	2212	2276	2340	2404	2468	2532	2596	2660	2724	2788	2852	2916	2980	3044	3108	3172	3236	3300	3364	3428	3492	3556	3620	3684	3748	3812	3876	3940	4004	4068
8 7 4	2086	2150	2214	2278	2342	2406	2470	2534	2598	2662	2726	2790	2854	2918	2982	3046	3110	3174	3238	3302	3366	3430	3494	3558	3622	3686	3750	3814	3878	3942	4006	4070
6 4	2088	2152	2216	2280	2344	2408	2472	2536	2600	2664	2728	2792	2856	2920	2984	3048	3112	3176	3240	3304	3368	3432	3496	3560	3624	3688	3752	3816	3880	3944	4008	4072
8 6 4	2090	2154	2218	2282	2346	2410	2474	2538	2602	2666	2730	2794	2858	2922	2986	3050	3114	3178	3242	3306	3370	3434	3498	3562	3626	3690	3754	3818	3882	3946	4010	4074
7 6 4	2092	2156	2220	2284	2348	2412	2476	2540	2604	2668	2732	2796	2860	2924	2988	3052	3116	3180	3244	3308	3372	3436	3500	3564	3628	3692	3756	3820	3884	3948	4012	4076
8 7 6 4	2094	2158	2222	2286	2350	2414	2478	2542	2606	2670	2734	2798	2862	2926	2990	3054	3118	3182	3246	3310	3374	3438	3502	3566	3630	3694	3758	3822	3886	3950	4014	4078
5 4	2096	2160	2224	2288	2352	2416	2480	2544	2608	2672	2736	2800	2864	2928	2992	3056	3120	3184	3248	3312	3376	3440	3504	3568	3632	3696	3760	3824	3888	3952	4016	4080
8 5 4	2098	2162	2226	2290	2354	2418	2482	2546	2610	2674	2738	2802	2866	2930	2994	3058	3122	3186	3250	3314	3378	3442	3506	3570	3634	3698	3762	3826	3890	3954	4018	4082
7 5 4	2100	2164	2228	2292	2356	2420	2484	2548	2612	2676	2740	2804	2868	2932	2996	3060	3124	3188	3252	3316	3380	3444	3508	3572	3636	3700	3764	3828	3892	3956	4020	4084
8 7 5 4	2102	2166	2230	2294	2358	2422	2486	2550	2614	2678	2742	2806	2870	2934	2998	3062	3126	3190	3254	3318	3382	3446	3510	3574	3638	3702	3766	3830	3894	3958	4022	4086
6 5 4	2104	2168	2232	2296	2360	2424	2488	2552	2616	2680	2744	2808	2872	2936	3000	3064	3128	3192	3256	3320	3384	3448	3512	3576	3640	3704	3768	3832	3896	3960	4024	4088
8 6 5 4	2106	2170	2234	2298	2362	2426	2490	2554	2618	2682	2746	2810	2874	2938	3002	3066	3130	3194	3258	3322	3386	3450	3514	3578	3642	3706	3770	3834	3898	3962	4026	4090
7 6 5 4	2108	2172	2236	2300	2364	2428	2492	2556	2620	2684	2748	2812	2876	2940	3004	3068	3132	3196	3260	3324	3388	3452	3516	3580	3644	3708	3772	3836	3900	3964	4028	4092
8 7 6 5 4	2110	2174	2238	2302	2366	2430	2494	2558	2622	2686	2750	2814	2878	2942	3006	3070	3134	3198	3262	3326	3390	3454	3518	3582	3646	3710	3774	3838	3902	3966	4030	4094

GEOMETRIC CODES

NOTE.—The highest or number twelve position in the punch card column is indicated as y in the geometric code and the next highest or eleventh position as x. There are ten geometric codes each of which is indicated by the punch card position number. The lowest position number in each code is one and must be punched for all odd numbers, together with the code for the preceding even number. Punch cards using this code can be arranged in order in the following manner: (a) sort with all boxes open, (b) block out the box corresponding to the lowest position in the code used and run cards in this box again, permitting all other cards to remain as they were sorted in their respective boxes, (c) block out successively higher boxes corresponding to the next higher punch card position, each time re-running the cards from the box which has been blocked out until all cards fall in the box corresponding to the highest position used.

Position (y-9)		3	2	2 3	1	1 3	1 2	1 2 3	0	0 3	0 2	0 2 3	0 1	0 1 3	0 1 2	0 1 2 3	x	x 3	x 2	x 2 3	x 1	x 1 3	x 1 2	x 1 2 3	x 0	x 0 3	x 0 2	x 0 2 3	x 0 1	x 0 1 3	x 0 1 2	x 0 1 2 3
	0	64	128	192	256	320	384	448	512	576	640	704	768	832	896	960	1024	1088	1152	1216	1280	1344	1408	1472	1536	1600	1664	1728	1792	1856	1920	1984
8	2	66	130	194	258	322	386	450	514	578	642	706	770	834	898	962	1026	1090	1154	1218	1282	1346	1410	1474	1538	1602	1666	1730	1794	1858	1922	1986
7	4	68	132	196	260	324	388	452	516	580	644	708	772	836	900	964	1028	1092	1156	1220	1284	1348	1412	1476	1540	1604	1668	1732	1796	1860	1924	1988
8 7	6	70	134	198	262	326	390	454	518	582	646	710	774	838	902	966	1030	1094	1158	1222	1286	1350	1414	1478	1542	1606	1670	1734	1798	1862	1926	1990
6	8	72	136	200	264	328	392	456	520	584	648	712	776	840	904	968	1032	1096	1160	1224	1288	1352	1416	1480	1544	1608	1672	1736	1800	1864	1928	1992
8 6	10	74	138	202	266	330	394	458	522	586	650	714	778	842	906	970	1034	1098	1162	1226	1290	1354	1418	1482	1546	1610	1674	1738	1802	1866	1930	1994
7 6	12	76	140	204	268	332	396	460	524	588	652	716	780	844	908	972	1036	1100	1164	1228	1292	1356	1420	1484	1548	1612	1676	1740	1804	1868	1932	1996
8 7 6	14	78	142	206	270	334	398	462	526	590	654	718	782	846	910	974	1038	1102	1166	1230	1294	1358	1422	1486	1550	1614	1678	1742	1806	1870	1934	1998
5	16	80	144	208	272	336	400	464	528	592	656	720	784	848	912	976	1040	1104	1168	1232	1296	1360	1424	1488	1552	1616	1680	1744	1808	1872	1936	2000
8 5	18	82	146	210	274	338	402	466	530	594	658	722	786	850	914	978	1042	1106	1170	1234	1298	1362	1426	1490	1554	1618	1682	1746	1810	1874	1938	2002
7 5	20	84	148	212	276	340	404	468	532	596	660	724	788	852	916	980	1044	1108	1172	1236	1300	1364	1428	1492	1556	1620	1684	1748	1812	1876	1940	2004
8 7 5	22	86	150	214	278	342	406	470	534	598	662	726	790	854	918	982	1046	1110	1174	1238	1302	1366	1430	1494	1558	1622	1686	1750	1814	1878	1942	2006
6 5	24	88	152	216	280	344	408	472	536	600	664	728	792	856	920	984	1048	1112	1176	1240	1304	1368	1432	1496	1560	1624	1688	1752	1816	1880	1944	2008
8 6 5	26	90	154	218	282	346	410	474	538	602	666	730	794	858	922	986	1050	1114	1178	1242	1306	1370	1434	1498	1562	1626	1690	1754	1818	1882	1946	2010
7 6 5	28	92	156	220	284	348	412	476	540	604	668	732	796	860	924	988	1052	1116	1180	1244	1308	1372	1436	1500	1564	1628	1692	1756	1820	1884	1948	2012
8 7 6 5	30	94	158	222	286	350	414	478	542	606	670	734	798	862	926	990	1054	1118	1182	1246	1310	1374	1438	1502	1566	1630	1694	1758	1822	1886	1950	2014
4	32	96	160	224	288	352	416	480	544	608	672	736	800	864	928	992	1056	1120	1184	1248	1312	1376	1440	1504	1568	1632	1696	1760	1824	1888	1952	2016
8 4	34	98	162	226	290	354	418	482	546	610	674	738	802	866	930	994	1058	1122	1186	1250	1314	1378	1442	1506	1570	1634	1698	1762	1826	1890	1954	2018
7 4	36	100	164	228	292	356	420	484	548	612	676	740	804	868	932	996	1060	1124	1188	1252	1316	1380	1444	1508	1572	1636	1700	1764	1828	1892	1956	2020
8 7 4	38	102	166	230	294	358	422	486	550	614	678	742	806	870	934	998	1062	1126	1190	1254	1318	1382	1446	1510	1574	1638	1702	1766	1830	1894	1958	2022
6 4	40	104	168	232	296	360	424	488	552	616	680	744	808	872	936	1000	1064	1128	1192	1256	1320	1384	1448	1512	1576	1640	1704	1768	1832	1896	1960	2024
8 6 4	42	106	170	234	298	362	426	490	554	618	682	746	810	874	938	1002	1066	1130	1194	1258	1322	1386	1450	1514	1578	1642	1706	1770	1834	1898	1962	2026
7 6 4	44	108	172	236	300	364	428	492	556	620	684	748	812	876	940	1004	1068	1132	1196	1260	1324	1388	1452	1516	1580	1644	1708	1772	1836	1900	1964	2028
8 7 6 4	46	110	174	238	302	366	430	494	558	622	686	750	814	878	942	1006	1070	1134	1198	1262	1326	1390	1454	1518	1582	1646	1710	1774	1838	1902	1966	2030
5 4	48	112	176	240	304	368	432	496	560	624	688	752	816	880	944	1008	1072	1136	1200	1264	1328	1392	1456	1520	1584	1648	1712	1776	1840	1904	1968	2032
8 5 4	50	114	178	242	306	370	434	498	562	626	690	754	818	882	946	1010	1074	1138	1202	1266	1330	1394	1458	1522	1586	1650	1714	1778	1842	1906	1970	2034
7 5 4	52	116	180	244	308	372	436	500	564	628	692	756	820	884	948	1012	1076	1140	1204	1268	1332	1396	1460	1524	1588	1652	1716	1780	1844	1908	1972	2036
8 7 5 4	54	118	182	246	310	374	438	502	566	630	694	758	822	886	950	1014	1078	1142	1206	1270	1334	1398	1462	1526	1590	1654	1718	1782	1846	1910	1974	2038
6 5 4	56	120	184	248	312	376	440	504	568	632	696	760	824	888	952	1016	1080	1144	1208	1272	1336	1400	1464	1528	1592	1656	1720	1784	1848	1912	1976	2040
8 6 5 4	58	122	186	250	314	378	442	506	570	634	698	762	826	890	954	1018	1082	1146	1210	1274	1338	1402	1466	1530	1594	1658	1722	1786	1850	1914	1978	2042
7 6 5 4	60	124	188	252	316	380	444	508	572	636	700	764	828	892	956	1020	1084	1148	1212	1276	1340	1404	1468	1532	1596	1660	1724	1788	1852	1916	1980	2044
8 7 6 5 4	62	126	190	254	318	382	446	510	574	638	702	766	830	894	958	1022	1086	1150	1214	1278	1342	1406	1470	1534	1598	1662	1726	1790	1854	1918	1982	2046

Position (y-9)	y	y 3	y 2	y 2 3	y 1	y 1 3	y 1 2	y 1 2 3	y 0	y 0 3	y 0 2	y 0 2 3	y 0 1	y 0 1 3	y 0 1 2	y 0 1 2 3	y x	y x 3	y x 2	y x 2 3	y x 1	y x 1 3	y x 1 2	y x 1 2 3	y x 0	y x 0 3	y x 0 2	y x 0 2 3	y x 0 1	y x 0 1 3	y x 0 1 2	y x 0 1 2 3
	2048	2112	2176	2240	2304	2368	2432	2496	2560	2624	2688	2752	2816	2880	2944	3008	3072	3136	3200	3264	3328	3392	3456	3520	3584	3648	3712	3776	3840	3904	3968	4032
8	2050	2114	2178	2242	2306	2370	2434	2498	2562	2626	2690	2754	2818	2882	2946	3010	3074	3138	3202	3266	3330	3394	3458	3522	3586	3650	3714	3778	3842	3906	3970	4034
7	2052	2116	2180	2244	2308	2372	2436	2500	2564	2628	2692	2756	2820	2884	2948	3012	3076	3140	3204	3268	3332	3396	3460	3524	3588	3652	3716	3780	3844	3908	3972	4036
8 7	2054	2118	2182	2246	2310	2374	2438	2502	2566	2630	2694	2758	2822	2886	2950	3014	3078	3142	3206	3270	3334	3398	3462	3526	3590	3654	3718	3782	3846	3910	3974	4038
6	2056	2120	2184	2248	2312	2376	2440	2504	2568	2632	2696	2760	2824	2888	2952	3016	3080	3144	3208	3272	3336	3400	3464	3528	3592	3656	3720	3784	3848	3912	3976	4040
8 6	2058	2122	2186	2250	2314	2378	2442	2506	2570	2634	2698	2762	2826	2890	2954	3018	3082	3146	3210	3274	3338	3402	3466	3530	3594	3658	3722	3786	3850	3914	3978	4042
7 6	2060	2124	2188	2252	2316	2380	2444	2508	2572	2636	2700	2764	2828	2892	2956	3020	3084	3148	3212	3276	3340	3404	3468	3532	3596	3660	3724	3788	3852	3916	3980	4044
8 7 6	2062	2126	2190	2254	2318	2382	2446	2510	2574	2638	2702	2766	2830	2894	2958	3022	3086	3150	3214	3278	3342	3406	3470	3534	3598	3662	3726	3790	3854	3918	3982	4046
5	2064	2128	2192	2256	2320	2384	2448	2512	2576	2640	2704	2768	2832	2896	2960	3024	3088	3152	3216	3280	3344	3408	3472	3536	3600	3664	3728	3792	3856	3920	3984	4048
8 5	2066	2130	2194	2258	2322	2386	2450	2514	2578	2642	2706	2770	2834	2898	2962	3026	3090	3154	3218	3282	3346	3410	3474	3538	3602	3666	3730	3794	3858	3922	3986	4050
7 5	2068	2132	2196	2260	2324	2388	2452	2516	2580	2644	2708	2772	2836	2900	2964	3028	3092	3156	3220	3284	3348	3412	3476	3540	3604	3668	3732	3796	3860	3924	3988	4052
8 7 5	2070	2134	2198	2262	2326	2390	2454	2518	2582	2646	2710	2774	2838	2902	2966	3030	3094	3158	3222	3286	3350	3414	3478	3542	3606	3670	3734	3798	3862	3926	3990	4054
6 5	2072	2136	2200	2264	2328	2392	2456	2520	2584	2648	2712	2776	2840	2904	2968	3032	3096	3160	3224	3288	3352	3416	3480	3544	3608	3672	3736	3800	3864	3928	3992	4056
8 6 5	2074	2138	2202	2266	2330	2394	2458	2522	2586	2650	2714	2778	2842	2906	2970	3034	3098	3162	3226	3290	3354	3418	3482	3546	3610	3674	3738	3802	3866	3930	3994	4058
7 6 5	2076	2140	2204	2268	2332	2396	2460	2524	2588	2652	2716	2780	2844	2908	2972	3036	3100	3164	3228	3292	3356	3420	3484	3548	3612	3676	3740	3804	3868	3932	3996	4060
8 7 6 5	2078	2142	2206	2270	2334	2398	2462	2526	2590	2654	2718	2782	2846	2910	2974	3038	3102	3166	3230	3294	3358	3422	3486	3550	3614	3678	3742	3806	3870	3934	3998	4062
4	2080	2144	2208	2272	2336	2400	2464	2528	2592	2656	2720	2784	2848	2912	2976	3040	3104	3168	3232	3296	3360	3424	3488	3552	3616	3680	3744	3808	3872	3936	4000	4064
8 4	2082	2146	2210	2274	2338	2402	2466	2530	2594	2658	2722	2786	2850	2914	2978	3042	3106	3170	3234	3298	3362	3426	3490	3554	3618	3682	3746	3810	3874	3938	4002	4066
7 4	2084	2148	2212	2276	2340	2404	2468	2532	2596	2660	2724	2788	2852	2916	2980	3044	3108	3172	3236	3300	3364	3428	3492	3556	3620	3684	3748	3812	3876	3940	4004	4068
8 7 4	2086	2150	2214	2278	2342	2406	2470	2534	2598	2662	2726	2790	2854	2918	2982	3046	3110	3174	3238	3302	3366	3430	3494	3558	3622	3686	3750	3814	3878	3942	4006	4070
6 4	2088	2152	2216	2280	2344	2408	2472	2536	2600	2664	2728	2792	2856	2920	2984	3048	3112	3176	3240	3304	3368	3432	3496	3560	3624	3688	3752	3816	3880	3944	4008	4072
8 6 4	2090	2154	2218	2282	2346	2410	2474	2538	2602	2666	2730	2794	2858	2922	2986	3050	3114	3178	3242	3306	3370	3434	3498	3562	3626	3690	3754	3818	3882	3946	4010	4074
7 6 4	2092	2156	2220	2284	2348	2412	2476	2540	2604	2668	2732	2796	2860	2924	2988	3052	3116	3180	3244	3308	3372	3436	3500	3564	3628	3692	3756	3820	3884	3948	4012	4076
8 7 6 4	2094	2158	2222	2286	2350	2414	2478	2542	2606	2670	2734	2798	2862	2926	2990	3054	3118	3182	3246	3310	3374	3438	3502	3566	3630	3694	3758	3822	3886	3950	4014	4078
5 4	2096	2160	2224	2288	2352	2416	2480	2544	2608	2672	2736	2800	2864	2928	2992	3056	3120	3184	3248	3312	3376	3440	3504	3568	3632	3696	3760	3824	3888	3952	4016	4080
8 5 4	2098	2162	2226	2290	2354	2418	2482	2546	2610	2674	2738	2802	2866	2930	2994	3058	3122	3186	3250	3314	3378	3442	3506	3570	3634	3698	3762	3826	3890	3954	4018	4082
7 5 4	2100	2164	2228	2292	2356	2420	2484	2548	2612	2676	2740	2804	2868	2932	2996	3060	3124	3188	3252	3316	3380	3444	3508	3572	3636	3700	3764	3828	3892	3956	4020	4084
8 7 5 4	2102	2166	2230	2294	2358	2422	2486	2550	2614	2678	2742	2806	2870	2934	2998	3062	3126	3190	3254	3318	3382	3446	3510	3574	3638	3702	3766	3830	3894	3958	4022	4086
6 5 4	2104	2168	2232	2296	2360	2424	2488	2552	2616	2680	2744	2808	2872	2936	3000	3064	3128	3192	3256	3320	3384	3448	3512	3576	3640	3704	3768	3832	3896	3960	4024	4088
8 6 5 4	2106	2170	2234	2298	2362	2426	2490	2554	2618	2682	2746	2810	2874	2938	3002	3066	3130	3194	3258	3322	3386	3450	3514	3578	3642	3706	3770	3834	3898	3962	4026	4090
7 6 5 4	2108	2172	2236	2300	2364	2428	2492	2556	2620	2684	2748	2812	2876	2940	3004	3068	3132	3196	3260	3324	3388	3452	3516	3580	3644	3708	3772	3836	3900	3964	4028	4092
8 7 6 5 4	2110	2174	2238	2302	2366	2430	2494	2558	2622	2686	2750	2814	2878	2942	3006	3070	3134	3198	3262	3326	3390	3454	3518	3582	3646	3710	3774	3838	3902	3966	4030	4094

Position (y−8)		2	1	1 2	0	0 2	0 1	0 1 2	x	x 2	x 1	x 1 2	x 0	x 0 2	x 0 1	x 0 1 2	y	y 2	y 1	y 1 2	y 0	y 0 2	y 0 1	y 0 1 2	y x	y x 2	y x 1	y x 1 2	y x 0	y x 0 2	y x 0 1	y x 0 1 2
	0	64	128	192	256	320	384	448	512	576	640	704	768	832	896	960	1024	1088	1152	1216	1280	1344	1408	1472	1536	1600	1664	1728	1792	1856	1920	1984
7	2	66	130	194	258	322	386	450	514	578	642	706	770	834	898	962	1026	1090	1154	1218	1282	1346	1410	1474	1538	1602	1666	1730	1794	1858	1922	1986
6	4	68	132	196	260	324	388	452	516	580	644	708	772	836	900	964	1028	1092	1156	1220	1284	1348	1412	1476	1540	1604	1668	1732	1796	1860	1924	1988
7 6	6	70	134	198	262	326	390	454	518	582	646	710	774	838	902	966	1030	1094	1158	1222	1286	1350	1414	1478	1542	1606	1670	1734	1798	1862	1926	1990
5	8	72	136	200	264	328	392	456	520	584	648	712	776	840	904	968	1032	1096	1160	1224	1288	1352	1416	1480	1544	1608	1672	1736	1800	1864	1928	1992
7 5	10	74	138	202	266	330	394	458	522	586	650	714	778	842	906	970	1034	1098	1162	1226	1290	1354	1418	1482	1546	1610	1674	1738	1802	1866	1930	1994
6 5	12	76	140	204	268	332	396	460	524	588	652	716	780	844	908	972	1036	1100	1164	1228	1292	1356	1420	1484	1548	1612	1676	1740	1804	1868	1932	1996
7 6 5	14	78	142	206	270	334	398	462	526	590	654	718	782	846	910	974	1038	1102	1166	1230	1294	1358	1422	1486	1550	1614	1678	1742	1806	1870	1934	1998
4	16	80	144	208	272	336	400	464	528	592	656	720	784	848	912	976	1040	1104	1168	1232	1296	1360	1424	1488	1552	1616	1680	1744	1808	1872	1936	2000
7 4	18	82	146	210	274	338	402	466	530	594	658	722	786	850	914	978	1042	1106	1170	1234	1298	1362	1426	1490	1554	1618	1682	1746	1810	1874	1938	2002
6 4	20	84	148	212	276	340	404	468	532	596	660	724	788	852	916	980	1044	1108	1172	1236	1300	1364	1428	1492	1556	1620	1684	1748	1812	1876	1940	2004
7 6 4	22	86	150	214	278	342	406	470	534	598	662	726	790	854	918	982	1046	1110	1174	1238	1302	1366	1430	1494	1558	1622	1686	1750	1814	1878	1942	2006
5 4	24	88	152	216	280	344	408	472	536	600	664	728	792	856	920	984	1048	1112	1176	1240	1304	1368	1432	1496	1560	1624	1688	1752	1816	1880	1944	2008
7 5 4	26	90	154	218	282	346	410	474	538	602	666	730	794	858	922	986	1050	1114	1178	1242	1306	1370	1434	1498	1562	1626	1690	1754	1818	1882	1946	2010
6 5 4	28	92	156	220	284	348	412	476	540	604	668	732	796	860	924	988	1052	1116	1180	1244	1308	1372	1436	1500	1564	1628	1692	1756	1820	1884	1948	2012
7 6 5 4	30	94	158	222	286	350	414	478	542	606	670	734	798	862	926	990	1054	1118	1182	1246	1310	1374	1438	1502	1566	1630	1694	1758	1822	1886	1950	2014
3	32	96	160	224	288	352	416	480	544	608	672	736	800	864	928	992	1056	1120	1184	1248	1312	1376	1440	1504	1568	1632	1696	1760	1824	1888	1952	2016
7 3	34	98	162	226	290	354	418	482	546	610	674	738	802	866	930	994	1058	1122	1186	1250	1314	1378	1442	1506	1570	1634	1698	1762	1826	1890	1954	2018
6 3	36	100	164	228	292	356	420	484	548	612	676	740	804	868	932	996	1060	1124	1188	1252	1316	1380	1444	1508	1572	1636	1700	1764	1828	1892	1956	2020
7 6 3	38	102	166	230	294	358	422	486	550	614	678	742	806	870	934	998	1062	1126	1190	1254	1318	1382	1446	1510	1574	1638	1702	1766	1830	1894	1958	2022
5 3	40	104	168	232	296	360	424	488	552	616	680	744	808	872	936	1000	1064	1128	1192	1256	1320	1384	1448	1512	1576	1640	1704	1768	1832	1896	1960	2024
7 5 3	42	106	170	234	298	362	426	490	554	618	682	746	810	874	938	1002	1066	1130	1194	1258	1322	1386	1450	1514	1578	1642	1706	1770	1834	1898	1962	2026
6 5 3	44	108	172	236	300	364	428	492	556	620	684	748	812	876	940	1004	1068	1132	1196	1260	1324	1388	1452	1516	1580	1644	1708	1772	1836	1900	1964	2028
7 6 5 3	46	110	174	238	302	366	430	494	558	622	686	750	814	878	942	1006	1070	1134	1198	1262	1326	1390	1454	1518	1582	1646	1710	1774	1838	1902	1966	2030
4 3	48	112	176	240	304	368	432	496	560	624	688	752	816	880	944	1008	1072	1136	1200	1264	1328	1392	1456	1520	1584	1648	1712	1776	1840	1904	1968	2032
7 4 3	50	114	178	242	306	370	434	498	562	626	690	754	818	882	946	1010	1074	1138	1202	1266	1330	1394	1458	1522	1586	1650	1714	1778	1842	1906	1970	2034
6 4 3	52	116	180	244	308	372	436	500	564	628	692	756	820	884	948	1012	1076	1140	1204	1268	1332	1396	1460	1524	1588	1652	1716	1780	1844	1908	1972	2036
7 6 4 3	54	118	182	246	310	374	438	502	566	630	694	758	822	886	950	1014	1078	1142	1206	1270	1334	1398	1462	1526	1590	1654	1718	1782	1846	1910	1974	2038
5 4 3	56	120	184	248	312	376	440	504	568	632	696	760	824	888	952	1016	1080	1144	1208	1272	1336	1400	1464	1528	1592	1656	1720	1784	1848	1912	1976	2040
7 5 4 3	58	122	186	250	314	378	442	506	570	634	698	762	826	890	954	1018	1082	1146	1210	1274	1338	1402	1466	1530	1594	1658	1722	1786	1850	1914	1978	2042
6 5 4 3	60	124	188	252	316	380	444	508	572	636	700	764	828	892	956	1020	1084	1148	1212	1276	1340	1404	1468	1532	1596	1660	1724	1788	1852	1916	1980	2044
7 6 5 4 3	62	126	190	254	318	382	446	510	574	638	702	766	830	894	958	1022	1086	1150	1214	1278	1342	1406	1470	1534	1598	1662	1726	1790	1854	1918	1982	2046

Position (y=6)		1	0	0 1	x	x 1	x 0	x 0 1	y	y 1	y 0	y 0 1	y x	y x 1	y x 0	y x 0 1
	0	32	64	96	128	160	192	224	256	288	320	352	384	416	448	480
5	2	34	66	98	130	162	194	226	258	290	322	354	386	418	450	482
4	4	36	68	100	132	164	196	228	260	292	324	356	388	420	452	484
5 4	6	38	70	102	134	166	198	230	262	294	326	358	390	422	454	486
3	8	40	72	104	136	168	200	232	264	296	328	360	392	424	456	488
5 3	10	42	74	106	138	170	202	234	266	298	330	362	394	426	458	490
4 3	12	44	76	108	140	172	204	236	268	300	332	364	396	428	460	492
5 4 3	14	46	78	110	142	174	206	238	270	302	334	366	398	430	462	494
2	16	48	80	112	144	176	208	240	272	304	336	368	400	432	464	496
5 2	18	50	82	114	146	178	210	242	274	306	338	370	402	434	466	498
4 2	20	52	84	116	148	180	212	244	276	308	340	372	404	436	468	500
5 4 2	22	54	86	118	150	182	214	246	278	310	342	374	406	438	470	502
3 2	24	56	88	120	152	184	216	248	280	312	344	376	408	440	472	504
5 3 2	26	58	90	122	154	186	218	250	282	314	346	378	410	442	474	506
4 3 2	28	60	92	124	156	188	220	252	284	316	348	380	412	444	476	508
5 4 3 2	30	62	94	126	158	190	222	254	286	318	350	382	414	446	478	510

Position (y=5)																
	0	16	32	48	64	80	96	112	128	144	160	176	192	208	224	240
4	2	18	34	50	66	82	98	114	130	146	162	178	194	210	226	242
3	4	20	36	52	68	84	100	116	132	148	164	180	196	212	228	244
4 3	6	22	38	54	70	86	102	118	134	150	166	182	198	214	230	246
2	8	24	40	56	72	88	104	120	136	152	168	184	200	216	232	248
4 2	10	26	42	58	74	90	106	122	138	154	170	186	202	218	234	250
3 2	12	28	44	60	76	92	108	124	140	156	172	188	204	220	236	252
4 3 2	14	30	46	62	78	94	110	126	142	158	174	190	206	222	238	254

Position (y=4)																
	0	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
3	2	10	18	26	34	42	50	58	66	74	82	90	98	106	114	122
2	4	12	20	28	36	44	52	60	68	76	84	92	100	108	116	124
3 2	6	14	22	30	38	46	54	62	70	78	86	94	102	110	118	126

Position (y=3)		0	x	x 0	y	y 0	y x	y x 0
	0	8	16	24	32	40	48	56
2	2	10	18	26	34	42	50	58
1	4	12	20	28	36	44	52	60
2 1	6	14	22	30	38	46	54	62

Position (y=2)		x	y	y x
	0	8	16	24
1	2	10	18	26
0	4	12	20	28
1 0	6	14	22	30

Position (y=1)		y
	0	8
0	2	10
x	4	12
0 x	6	14

Position (y=0)	
	0
x	2
y	4
x y	6

Position (y=7)		1	0	0 1	x	x 1	x 0	x 0 1	y	y 1	y 0	y 0 1	y x	y x 1	y x 0	y x 0 1
	0	64	128	192	256	320	384	448	512	576	640	704	768	832	896	960
6	2	66	130	194	258	322	386	450	514	578	642	706	770	834	898	962
5	4	68	132	196	260	324	388	452	516	580	644	708	772	836	900	964
6 5	6	70	134	198	262	326	390	454	518	582	646	710	774	838	902	966
4	8	72	136	200	264	328	392	456	520	584	648	712	776	840	904	968
6 4	10	74	138	202	266	330	394	458	522	586	650	714	778	842	906	970
5 4	12	76	140	204	268	332	396	460	524	588	652	716	780	844	908	972
6 5 4	14	78	142	206	270	334	398	462	526	590	654	718	782	846	910	974
3	16	80	144	208	272	336	400	464	528	592	656	720	784	848	912	976
6 3	18	82	146	210	274	338	402	466	530	594	658	722	786	850	914	978
5 3	20	84	148	212	276	340	404	468	532	596	660	724	788	852	916	980
6 5 3	22	86	150	214	278	342	406	470	534	598	662	726	790	854	918	982
4 3	24	88	152	216	280	344	408	472	536	600	664	728	792	856	920	984
6 4 3	26	90	154	218	282	346	410	474	538	602	666	730	794	858	922	986
5 4 3	28	92	156	220	284	348	412	476	540	604	668	732	796	860	924	988
6 5 4 3	30	94	158	222	286	350	414	478	542	606	670	734	798	862	926	990
2	32	96	160	224	288	352	416	480	544	608	672	736	800	864	928	992
6 2	34	98	162	226	290	354	418	482	546	610	674	738	802	866	930	994
5 2	36	100	164	228	292	356	420	484	548	612	676	740	804	868	932	996
6 5 2	38	102	166	230	294	358	422	486	550	614	678	742	806	870	934	998
4 2	40	104	168	232	296	360	424	488	552	616	680	744	808	872	936	1000
6 4 2	42	106	170	234	298	362	426	490	554	618	682	746	810	874	938	1002
5 4 2	44	108	172	236	300	364	428	492	556	620	684	748	812	876	940	1004
6 5 4 2	46	110	174	238	302	366	430	494	558	622	686	750	814	878	942	1006
3 2	48	112	176	240	304	368	432	496	560	624	688	752	816	880	944	1008
6 3 2	50	114	178	242	306	370	434	498	562	626	690	754	818	882	946	1010
5 3 2	52	116	180	244	308	372	436	500	564	628	692	756	820	884	948	1012
6 5 3 2	54	118	182	246	310	374	438	502	566	630	694	758	822	886	950	1014
4 3 2	56	120	184	248	312	376	440	504	568	632	696	760	824	888	952	1016
6 4 3 2	58	122	186	250	314	378	442	506	570	634	698	762	826	890	954	1018
5 4 3 2	60	124	188	252	316	380	444	508	572	636	700	764	828	892	956	1020
6 5 4 3 2	62	126	190	254	318	382	446	510	574	638	702	766	830	894	958	1022

2	128
3	64
4	32
5	16
6	8
7	4
8	2
9	1

All intermediate quantities, from 1 to 4,095, can be formed by addition of these quantities, and they can be formed in only one way. For example, 13 can be formed only by a punch of positions, 6, 7 and 9, which, transferred into the corresponding numbers of the geometric progression in the list just given, are equivalent to 8+4+1=13. If every position in a column is punched the total represented equals 4,095. Obviously, the possibilities of designating different numbers, using such a device, are far in excess of those offered by other codes.

To use the geometric code, a table such as that given with this paper is necessary. This table is the geometric code and represents all the additions that can be made. To examine this code: At the bottom and furthest to the right is a group of symbols and numerals above which is the expression "Position (*y*—0)" which indicates that when one is coding data which fall within the field of application of this group, one is concerned only with column positions *y* to zero. In the geometric code, other groups are designated (*y*—1), (*y*—2), (*y*—3) and so on up to (*y*—9).

Above a heavy horizontal line are scattered symbols and numerals; to the left of a heavy vertical line are scattered numerals. Embraced in the right angle formed by these heavy lines are quantities of an arithmetic progression. If one were told to find a given symbol or numeral above the horizontal line and to find a given numeral to the left of the vertical line and then to read downward in the vertical line so designated and to the right in the horizontal line so designated until the lines crossed, one would find that the crossing took place on one of the quantities of the arithmetic progression. This quantity represents a fact which it is desired to code. What fact it represents could be determined, were there any occasion for it, by a list, which now will be explained, and afterward, an example will be given.

The list of data to be coded, of course, will depend on the kind of work in the office where the code is being used. Suppose the office is the statistical department of a hospital. Many diverse facts about each patient must be coded: his age, race, residence, date of admission, diagnosis, operations, a host of things even to the amount of his bill. There must be a place on the punch card for each of these facts. Facts of a similar kind are grouped together in the list. This list is available to the coding clerk. Opposite each group in the list is printed a certain range of positions in the geometric code, $y-1$, $y-2$ and so forth, and a column number of the punch card.

Now the example: The coding clerk wishes to punch a patient's card so that it will show that he was in the hospital for eighty-three days. The list available to the clerk says that days in hospital are punched in column 29 of the punch card, and in positions in that column from zero to 9. This range, zero to 9, is included within the range y to 9 in the geometric code. Therefore, the clerk refers to that group of quantities in the geometric code which is designated $(y-9)$. The quantity 83 is an odd number and does not appear in the arithmetic progression. Therefore the clerk finds 82, which is in vertical line 3 and in horizontal line 8, 5. The greatest position in any range represents the quantity 1. The range applicable in the present example is zero to 9. Therefore, for this example 9 in column 29 represents the additional quantity, 1, which is needed to make the required quantity of 83 days. Accordingly in column 29 on the punch card the clerk punches 3, 8, 5 and 9.

To punch for diagnosis, columns 74 to 79 of the punch card are used, and an intermediate code is employed which is available to the coding clerk and is easily learned and applied.

It might be thought that this system of coding, which requires the use of intermediate steps, would be unduly difficult to understand. Nevertheless, it has not proved so. Working of three to five examples has proved sufficient to introduce the principles to new coding clerks. Certainly, it opens the way for practically inexhaustible expansion, and in the actual routine of a statistical department reduces time and effort as well as making available the gathering of facts hitherto impossible of access in a reasonable time.

ADDITIONAL ADVANTAGES OF THE GEOMETRIC CODE

The geometric code substitutes one consistent code for many. For example, if body weight could not be assigned 3 columns in a punch card, it could be punched in one column by this code instead of being grouped by intervals of 5 or 10 pounds.

It facilitates the summation of totals and averages. If the sorting machine is wired to the card counting-printer, a single run at the sorting speed of 450 a minute will permit computation of the total and the average. For example, suppose that on 1,000 punch cards money charges for services rendered or goods sold range from $1 to $3,000 punched in a certain column by this code. The result is as follows:

Punch position	Dollars for which punch position stands	Number of positions which have been punched in all the cards	Total dollars for each position
Y	2,048	1	2,048
X	1,024	2	2,048
0	512	10	5,120
1	256	21	5,376
2	128	37	4,736
3	64	152	9,728
4	32	86	2,752
5	16	50	800
6	8	80	640
7	4	120	480
8	2	210	420
9	1	512	512
			34,660

The total charge is $34,660 and since there are 1,000 punch cards the average per card is $34.66. The time saving of this process is very considerable, because it involves a difference between sorting speed at 450 a minute and tabulating speed of 75 to 150 a minute. It obtains then, the advantages of capacity, coding and a faster computation of totals and averages without sacrificing the opportunity of arranging all charges in order of magnitude. The process of ordering is given in the caption of the table.

GRAPHIC PRESENTATION OF STANDARD DEVIATION

BY LEWIS A. MAVERICK

Standard deviation [1] is commonly computed arithmetically; it may, however, be computed graphically. The graphic method here presented has as its chief advantage a pictorial quality which aids to an understanding of the concept of standard deviation. Unfortunately, the graphic method is not rapid, and consequently is not suited to routine calculations. This article presents several applications of the method to time series, in which field it offers an accuracy equal to that of the conventional arithmetic procedure, and a unique adaptability to changing complexity in the time series, in that readings may be taken at varying intervals, at times selected to make possible the transcription of the details of the curve to a new chart on which measurements are to be made for the final calculations. The article also presents an application of the graphic method to frequency distributions, but in this case nothing is claimed for it beyond its illustrative character.

METHODS I AND II, TIME SERIES

Two graphic methods may be used to compute the standard deviation of actual values from the trend. They may be applied advantageously when the curve of actual values is not a disjointed series of straight lines connecting discrete points but a flowing curve based on a moving average or similar smoothing, and when the trend, which is, of course, a smooth curve, is the base of reference, rather than the more complex curve of normal values. Given such a chart of smoothed curve and trend, as Chart I, a second chart is constructed, on which the trend is represented by a horizontal line and the deviations or their squares plotted as ordinates from the trend as a base (Chart III, IV, or VI). The measurement of the deviations to be plotted on the second chart will be facilitated if the original chart (Chart I) is on logarithmic paper rather than arithmetic, because the properties of logarithmic paper contribute to the calculations: the ratio of actual

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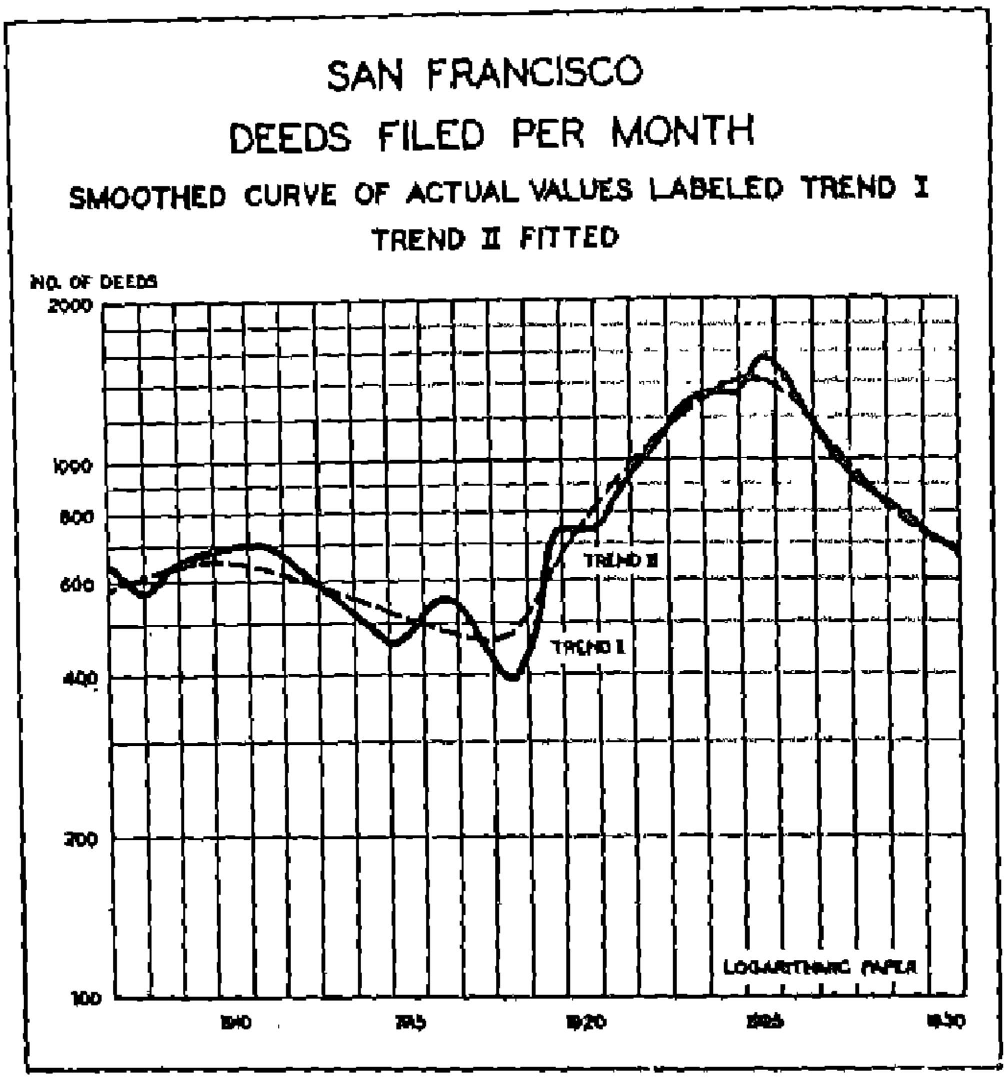
[1] The standard deviation, a widely used measure of the "scatter" of a set of values of some variable, is the root-mean-square deviation of the variate values from a suitable central tendency. In time series, the central tendency selected is commonly trend or normal; in frequency distributions, the arithmetic mean. Let n be the number of items observed; d the deviation of an item from the central tendency (either in actual units or in per cent); and *s.d.* the standard deviation. Then

$$\text{s.d.} = \sqrt{\frac{\Sigma d^2}{n}}.$$

CHART I



to trend is directly revealed, making unnecessary the reading of two ordinates and dividing; by the aid of a strip scale, the relative deviation of actual from trend may be read directly; or by the aid of a second scale, the square of the relative deviation may be read directly.

The deviation readings need not be made at uniform time intervals, but instead may be made infrequently where the curvature is smooth and more frequently where sharp or changing; the sole purpose of the readings is to supply sufficient detail for the construction of Chart III, IV, or VI.

Construction of the scales for reading the relative deviation and the square of the relative deviation.—The character of logarithmic paper makes it much like a slide rule, but lacking the movable scale. That scale may be supplied in the form of a strip cut from the same logarithmic paper; the scale may then be placed on the chart and multiplication and division effected "graphically." Furthermore, just as special scales may be constructed for slide-rule computation, so special scales may be constructed for the application of particular formulas to the ratios shown on a logarithmic chart.

To read the ratio of actual to trend, use as scale a strip cut from the same logarithmic paper as the chart. Apply to the chart so that the unit point comes opposite the trend; the scale reading opposite the actual value then will be the desired ratio of actual to trend.

To read the relative deviation of actual from trend (as used in Method Ib, Chart IV; also Method II, Chart VI) the same ruling on the strip scale may be used, but with new numbers written in. At the unit or 100 point of the scale write *zero;* at 110 write *+.10;* at 150, *+.50;* at 90, *−.10;* etc. The zero point of this scale should be placed opposite the trend; then the scale reading opposite the actual value will be the desired relative deviation. (If the scale numbers be multiplied by 100, changing them to *0, +10, +50, −10,* etc., the scale will indicate percentage deviation.)

In order to construct a strip scale which will permit direct reading of the square of the relative deviation (as used in Method Ia, Chart III) a simple formula may be used.

Let d = relative deviation of actual from trend
and r = ratio of actual to trend.
Then $d=r-1$ and $d^2=(r-1)^2$.
Also percentage deviation = 100 d.

A table of values of d^2 and r may be prepared from the equation $d^2=(r-1)^2$. Table I has been so computed and from it Chart II

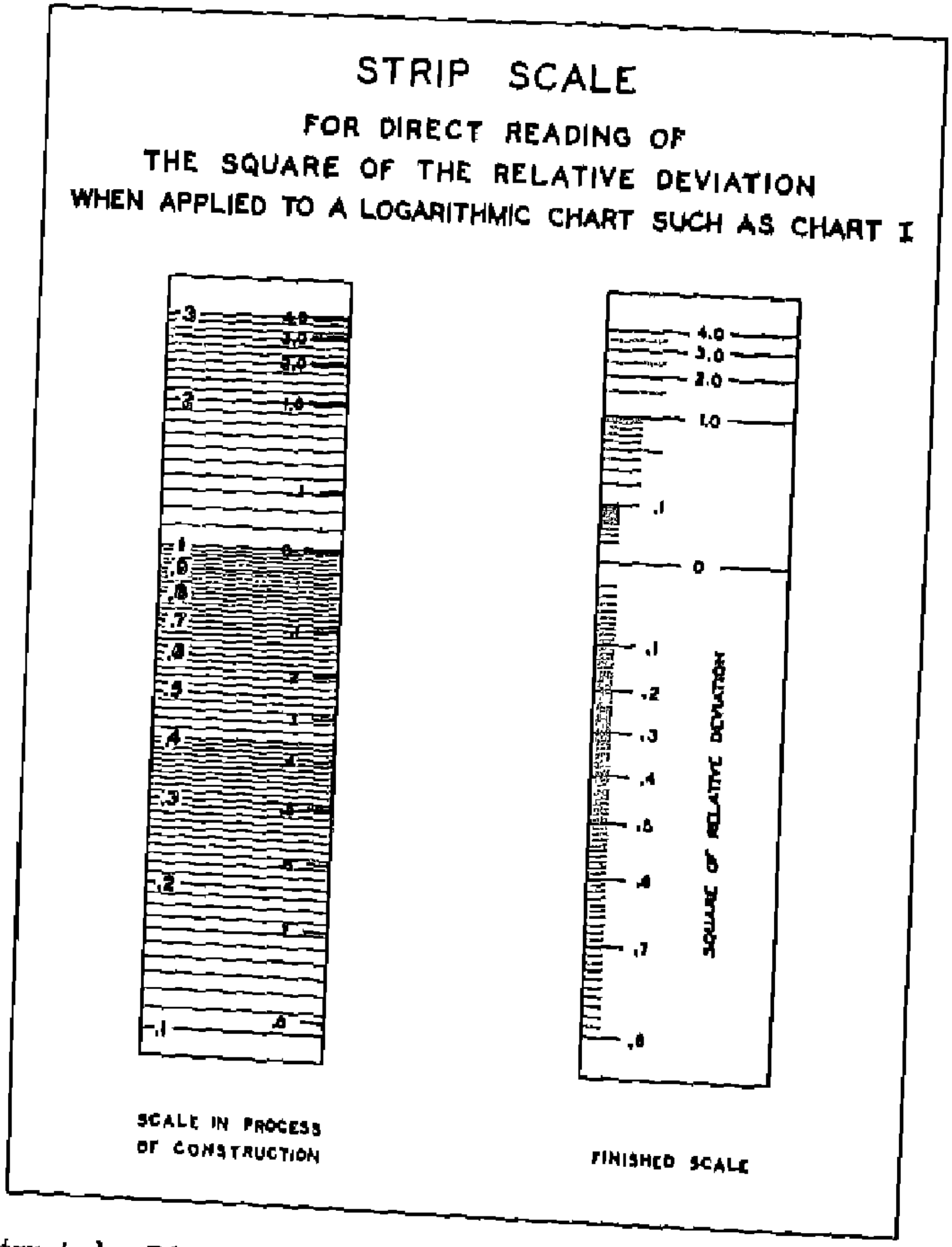
TABLE I

CORRESPONDING VALUES OF RATIO OF ACTUAL VALUE TO TREND, r, AND SQUARE OF DEVIATION FROM TREND, d^2

(To accompany Methods I and II)

Values of d^2; to be marked on scale	Corresponding values of r; to determine location of the d^2 points on the logarithmic scale
4.0	3.000
2.0	2.414
1.0	2.000
.1	1.316
.01	1.100
0.00	1.000
.01	.900
.1	.684
.2	.553
.3	.452
.4	.368
.5	.293
.6	.225
.7	.163
.8	.106

CHART II

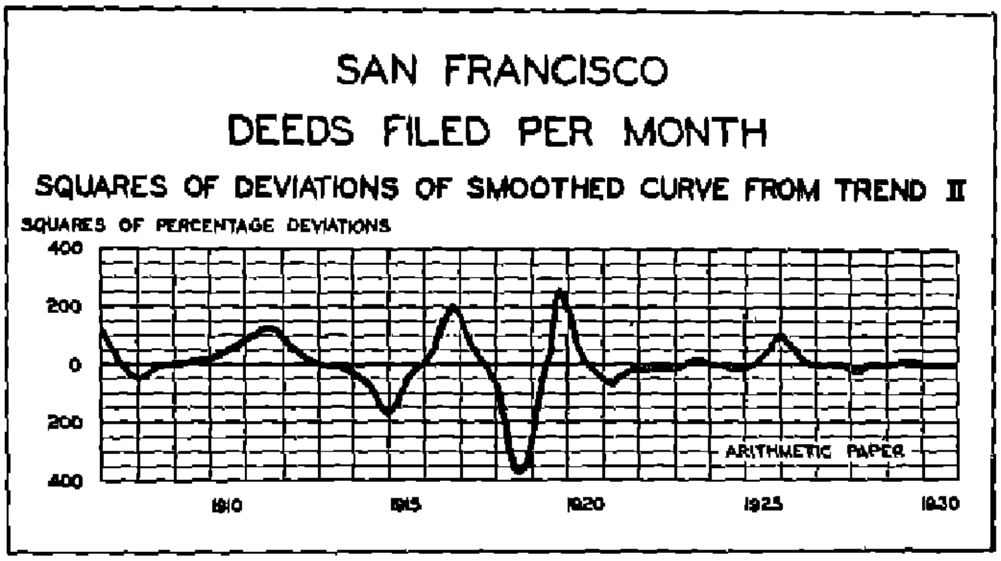

STRIP SCALE
FOR DIRECT READING OF
THE SQUARE OF THE RELATIVE DEVIATION
WHEN APPLIED TO A LOGARITHMIC CHART SUCH AS CHART I
4.0
3.0
2.0
1.0
.1
0
.1
.2
.3
.4
.5
.6
.7
.8
SQUARE OF RELATIVE DEVIATION
SCALE IN PROCESS OF CONSTRUCTION
FINISHED SCALE

constructed. The points from the table were located on logarithmic paper, and then transcribed to a strip of blank paper, which is used as the scale. When applied to Chart I, this scale permits the direct reading of d^2, the square of the relative deviation of actual from trend.

METHOD I, TIME SERIES, MEASUREMENT OF AREAS

Method Ia, Squares of Deviations Plotted on Arithmetic Paper.—Method I provides two ways of securing a chart of the squares of the deviations. Under the first of these procedures (Ia), a chart of the type of Chart III is constructed: Values of the squares of the devia-

CHART III



tions are secured and plotted on a simple arithmetic chart, up or down from the base line according to the sign of the first power of the deviation. The points are connected by a smooth curve which simulates the relationships exhibited on Chart I, but distorted because of the squaring.[1]

All areas between the base line and the curve are measured by planimeter and are given positive values (the position of part of the curve below the base line is solely for the purpose of visual comparison with Chart I, and does not imply any qualification of the simple statement that the square of a negative number is positive) and the sum of the areas secured. This aggregate area, empirically determined, is Σd^2; it may be divided by the time, and the square root of the quotient taken, giving the desired quantity, the standard deviation of the smoothed time series from its trend.

Method Ib, Deviations Plotted on "Squares" Paper.—An alternative representation of squared deviations appears in Chart IV. This requires the use of specially ruled paper, which may be called "squares paper." If this method is to be used, then not the square of the deviation of the actual value from the trend, but the first power, is read from Chart I. For this purpose, as has been explained above, a strip

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[1] The distortion is regular, and a knowledge of its peculiarities will help in sketching in the curve of squares of deviations. Where the curve of deviations crosses the base line at an angle, the curve of squares of deviations is tangent to the base; where the deviation has a maximum arithmetic value, the sharpness of the peak or trough is exaggerated in the curve of squares of deviations, a positive kurtosis. It would, of course, be equally accurate arithmetically and more consistent algebraically to plot the squares of all deviations on the upper or positive side of the base line; with this procedure the tangency of the curve of squares to the base line at points where the curve of deviations crosses the base line would be even clearer in its algebraic meaning. The reason this truer procedure is not elaborated in this article is that a genuine pictorial gain is effected by plotting the square of negative deviations below the base line.

CHART IV

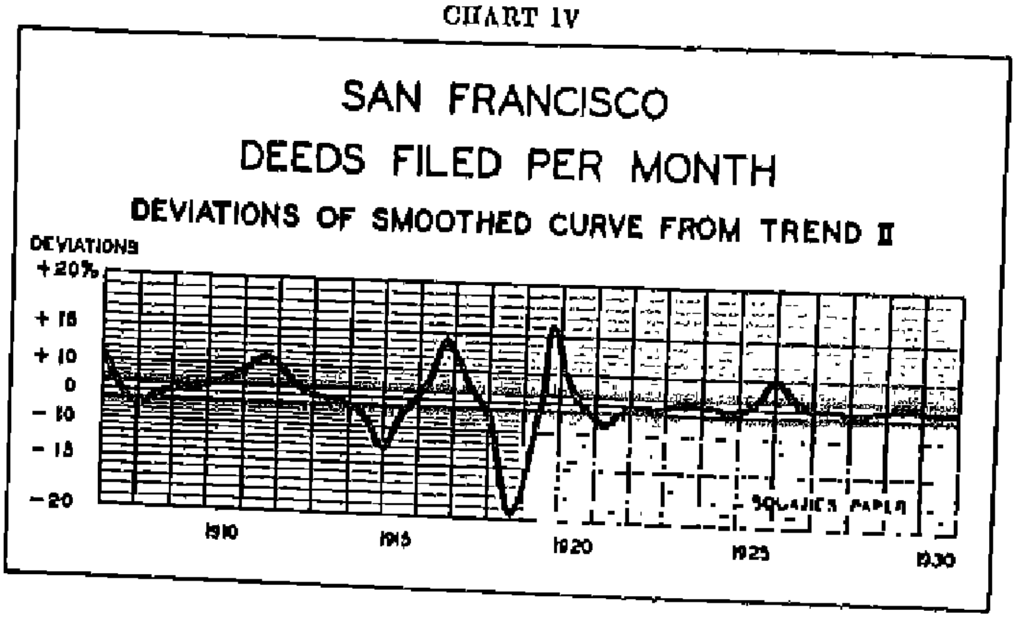
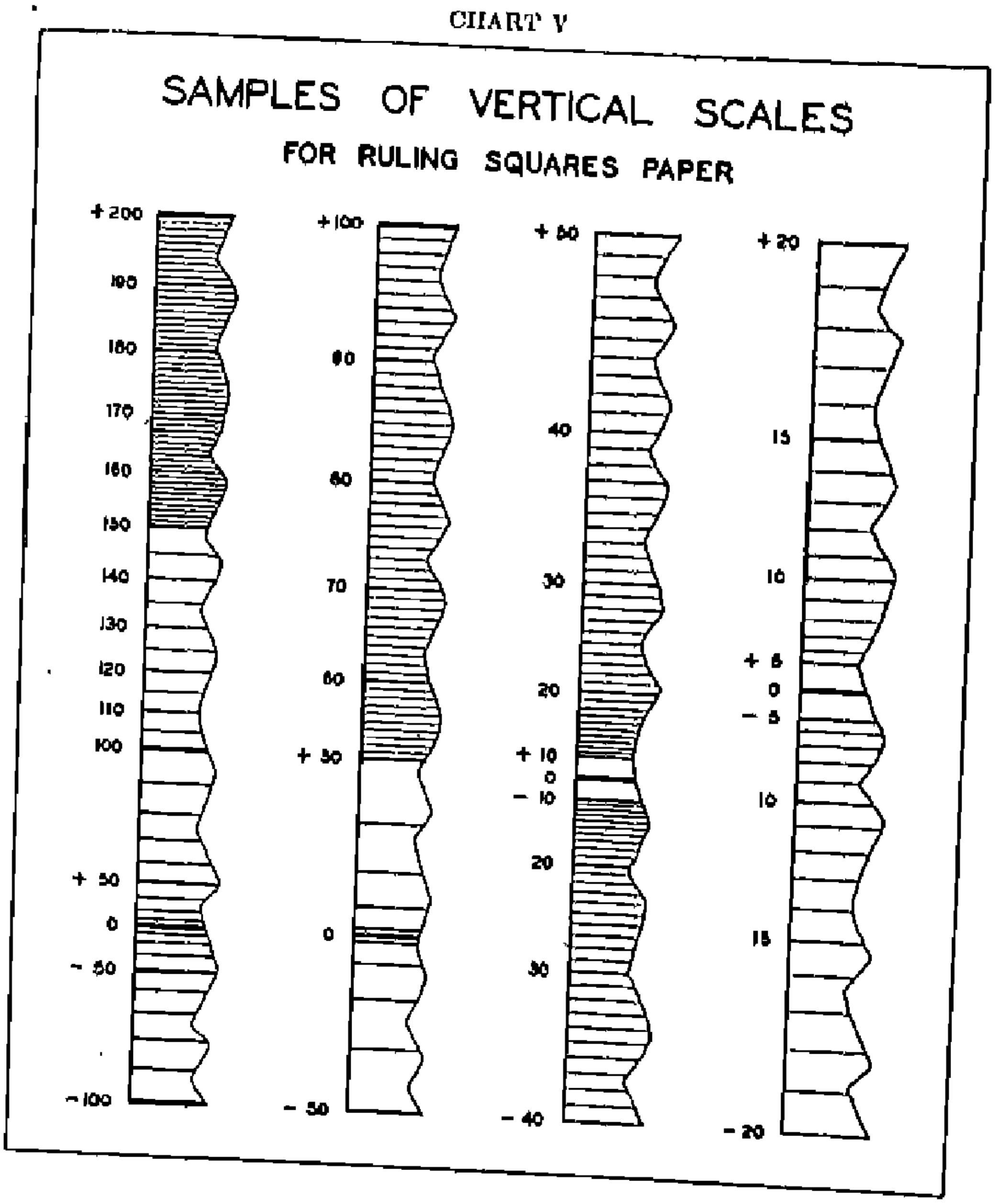


CHART V



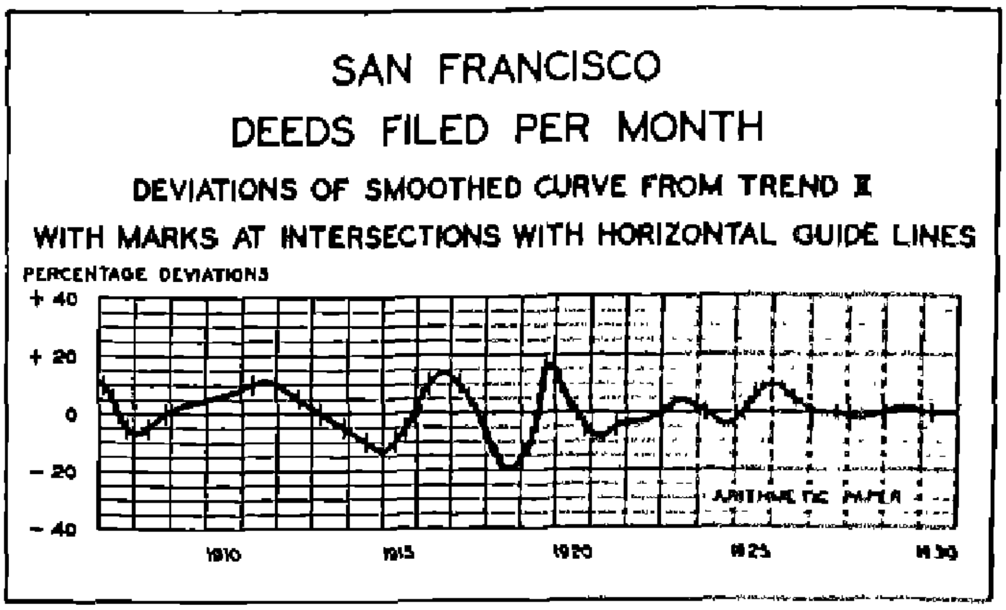
scale is used which has been cut from logarithmic paper of the same deck width as that used in Chart I. The squares paper may be ruled as in Chart IV or to suit other amplitudes of deviation, as in the samples in Chart V. The horizontal scale is arithmetic; the vertical scale is laid off from a base line near the center of the sheet in lengths proportional to the squares of the common numbers, though labeled with the first powers of those numbers. On this paper, the scale location of a deviation gives directly an ordinate whose arithmetic length is in proportion to the square rather than to the first power of the deviation. The curve obtained by plotting the first powers of the deviations on squares paper, Chart IV, is the same as that secured by plotting the squares of the deviations on arithmetic paper, Chart III. The further procedure of measuring areas and computing the standard deviation is the same as in Method Ia.

METHOD II, TIME SERIES, REDUCTION TO FREQUENCY DISTRIBUTION

In place of the first method, which involves the plotting of squared deviations and the measurement of areas by planimeter, an alternative graphic method may be employed, as illustrated in Chart VI. This method retains the advantage realized under Method I, of responding to the varying degrees of complexity or simplicity in the relationship of the curve to its trend. It reduces the time series to a weighted or frequency distribution, for which the standard deviation may be computed arithmetically. The details of the method may best be presented in a numerical example.

The relative deviations from trend may be read from Chart I and plotted up and down from a horizontal base or 100 per cent line, as has been done on Chart VI. Wherever the curve of relative deviations crosses a printed horizontal guide line, the intersection may be marked by a short vertical check, to fix clearly the date of the intersection. The element of time which will be of concern is that between two successive vertical checks. Consider, for example, the third quarter of the year 1919. Here an "element" of time is comprised between the intersection of the curve with the +10 per cent line and its intersection with the +15 per cent line. This particular element is about 1/10 year in length, and the mean ordinate, +12.5 per cent, may without significant error be taken to be the median ordinate or median deviation of the elementary section of the curve. All the elementary sections of the curve which display the same deviation, regardless of sign, are to be brought together and entered into a frequency table, in which the total time length of the elementary sections will be taken as the weight or "frequency" of the particular deviation. For accurate

CHART VI



work, however, special treatment must be given a particular class of items which defy assimilation into the frequency table, namely the points of maximum and minimum, the peaks and troughs. These elements must be handled individually, and the "representative" deviation of the element separately estimated for each.

TABLE II

DETERMINATION OF WEIGHTS TO BE ASSIGNED DEVIATIONS

(To accompany Method II)

Figures taken from Chart VI

Time measured in years from January 1, 1907

Ordinates to the intersected guide lines

(A) Time	(B) Ordinate	(C) Time Interval	(D) Mid-Ordinate	(A) Time	(B) Ordinate	(C) Time Interval	(D) Mid-Ordinate
0.2	+10			11.2	−10	.3	− 7.5
.4	+ 5	.2	+ 7.5	11.3	−15	.1	−12.5
.6	0	.2	+ 2.5	12.1	−15	.8	−17 *
.8	− 5	.2	− 2.5	12.3	−10	.2	−12.5
1.3	− 5	.5	− 5 *	12.4	− 5	.1	− 7.5
1.8	0	.5	− 2.5	12.5	0	.1	− 2.5
3.0	+ 5	1.2	+ 2.5	12.6	+ 5	.1	+ 2.5
4.3	+10	1.3	+ 7.5	12.7	+10	.1	+ 7.5
5.0	+10	.7	+11 *	12.8	+15	.1	+12.5
5.7	+ 5	.7	+ 7.5	13.0	+15	.2	+16 *
6.2	0	.5	+ 2.5	13.2	+10	.2	+12.5
6.8	− 5	.6	− 2.5	13.4	+ 5	.2	+ 7.5
7.5	−10	.7	− 7.5	13.6	0	.2	+ 2.5
8.3	−10	.8	−12 *	13.8	− 5	.2	− 2.5
8.6	− 5	.3	− 7.5	14.7	− 5	.9	− 7 *
8.9	0	.3	− 2.5	16.0	0	1.3	− 2.5
9.1	+ 5	.2	+ 2.5	17.2	0	1.2	+ 2 *
9.4	+10	.3	+ 7.5	18.2	0	1.0	− 2 *
10.3	+10	.9	+12 *	18.6	+ 5	.4	+ 2.5
10.5	+ 5	.2	+ 7.5	19.6	+ 5	1.1	+ 7.5 *
10.7	0	.2	+ 2.5	20.7	0	1.1	+ 2.5
10.9	− 5	.2	− 2.5	22.0	0	1.3	− 1 *
				23.2	0	1.2	+ 1 *

* Asterisk marks maxima and minima.

Table II presents figures from Chart VI. Column A gives the time of each intersection, in years from January 1, 1907; Column B the ordinate to the intersecting guide line; Column C the length in years of each intercepted interval; and Column D the mid-ordinate or deviation of the interval. It will be noted that in Column D each peak and trough (marked with asterisk) is given a specially estimated ordinate or deviation, as in these cases the mid-ordinate between guide lines is not representative.

There follows Table III, a frequency table of the deviations from trend, in which deviations of the same arithmetic magnitude are brought together, and in which those deviations which mark the maxima and the minima, and which consequently are not readily combined, are listed individually. For the deviations of both classes, weights are assigned in accordance with the number of years that the deviations are found to obtain. In Table IV the frequency table is handled in orthodox fashion and the standard deviation computed arithmetically.

TABLE III

ASSEMBLING FROM TABLE II OF WEIGHTS TO BE ASSIGNED DEVIATIONS

(To accompany Method II)
Weights in years

Deviations + or — excluding maxima and minima			Deviations + or — for maxima and minima (the ordinate is separately estimated for each case)							
12.5%	7.5%	2.5%	1%	2%	6%	7%	11%	12%	16%	17%
Weights in years										
.6	5.5	7.4	2.5	2.2	.5	.9	.7	1.7	.2	.8

TABLE IV

CALCULATION OF STANDARD DEVIATION FROM FIGURES IN TABLE III

(To accompany Method II)

d (per cent)	(f weight in years)	d^2	fd^2
12.5	.6	156	93.6
7.5	5.5	56	308.0
2.5	7.4	6	44.4
17	.8	289	231.2
16	.2	256	51.2
12	1.7	144	244.8
11	.7	121	84.7
7	.9	49	44.1
6	.5	36	18.0
2	2.2	4	8.8
1	2.5	1	2.5

$$\frac{\Sigma fd^2}{N}=\frac{1131.3}{23}=49.19$$

$\sqrt{49.19}=7.01$ per cent, say 7 per cent, the standard deviation

$N=\Sigma f=23.0$ years $\qquad \Sigma fd^2=1{,}131.3$

METHOD III, FREQUENCY DISTRIBUTIONS, THE STANDARD DEVIATION FROM THE MEAN, AREA UNDER THE OGIVE

Graphic methods may not be practicably employed for the computation of the standard deviation of a frequency distribution, but they have an illustrative quality. A simple frequency distribution is presented below, for which the standard deviation is computed arithmetically in Table V and graphically by aid of Chart VII. The arithmetic procedure needs no textual description.

On Chart VII, a horizontal base line is selected; along it the successive class frequencies are measured and the mid-point of each class located; at this central point an ordinate is erected of length proportional to the square of the corresponding deviation; the points so obtained are joined by an ogive curve which extends to the limits of the distribution. The area between the curve and the base represents the sum of the squares of the deviations from the mean. Here, as in Method I, Charts III and IV, the area below the base is positive. The total area of the figure in Chart VII is 55.7, in units which are the product of one item or frequency by the square of a deviation of $1.00. The total area, 55.7, divided by the gross frequency, 41, gives a quotient 1.36, the mean square deviation. The square root of this number is $1.16, the quantity sought, the standard deviation. This result may be compared with the value $1.10, obtained by the arithmetic procedure. When the graphic method is applied to frequency dis-

TABLE V

FREQUENCY DISTRIBUTION: COMPUTATION OF STANDARD DEVIATION FROM THE MEAN

(To accompany Method III)

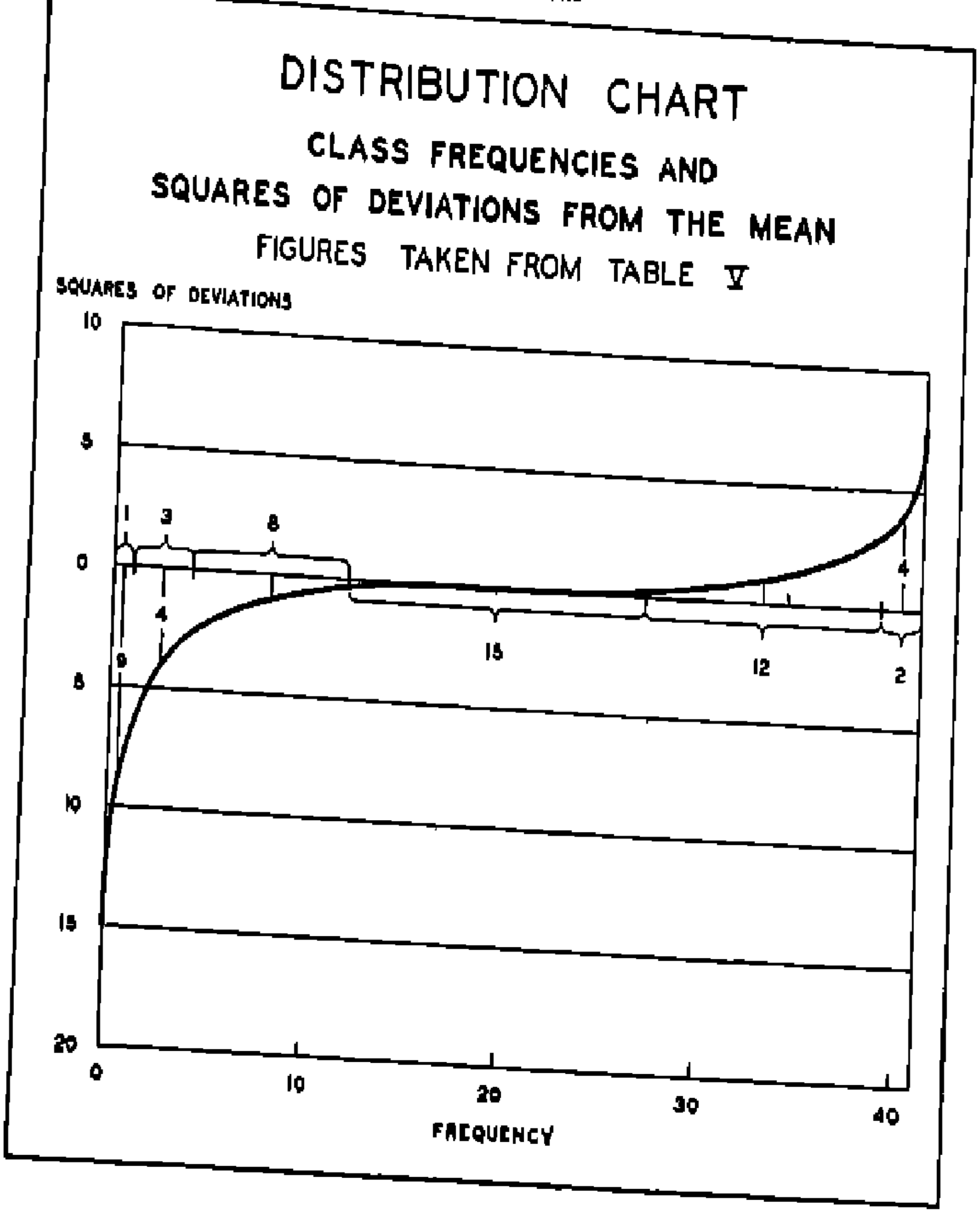
Variable v		Frequency f	vf	Deviation from mean d	d^2	fd^2
Class-limits	Mid-point					
$10.50-11.49	$11	1	$ 11	−3	9	9
11.50-12.49	12	3	36	−2	4	12
12.50-13.49	13	8	104	−1	1	8
13.50-14.49	14	15	210	0	0	0
14.50-15.49	15	12	180	+1	1	12
15.50-16.49	16	2	32	+2	4	8
		$n=41$	$573			$\Sigma fd^2=49$

$$\text{Mean}=\frac{573}{41}=\$13.98, \text{ say } \$14.00$$

$$\frac{\Sigma fd^2}{n}=\frac{49}{41}=1.1951$$

$$s.d.=\sqrt{1.1951}=\$1.09, \text{ say } \$1.10$$

CHART VII



tributions, there is regularly a bias toward a larger value of the standard deviation than by the arithmetic computation. If for the smooth ogive curve a column diagram or histogram were substituted, then the graphic presentation would be merely a replica of the arithmetic. The disparity in the results by the two methods may serve as an introduction to the question whether the items should be viewed as concentrated at the mid-point of the class or as distributed evenly through it.

NOTES

ON THE COEFFICIENT OF PART CORRELATION

By Harold D. Griffin, *Nebraska State Teachers College*

When the coefficient of multiple correlation and the multiple regression equation have been obtained by partial regression methods such as determinants, the Doolittle or iteration methods,[1] subsequent computation of a partial correlation coefficient is somewhat involved. But the calculation of an alternative concept, the coefficient of part correlation, is a simple matter when the formula is stated in terms of "beta" coefficients, as was suggested by Donald R. G. Cowan in the June number of this Journal,[2] and computed by the nomographic chart accompanying this article.

The coefficient of part correlation is a new measure developed by Bradford B. Smith and Mordecai M. B. Ezekiel.[3] Smith gives the symbol as ${}_1r_{0\cdot23}$; while Ezekiel, whom Cowan follows, prefers the symbol ${}_{01}r_{23}$. The writer's nomographic chart follows Smith's form. This slight difference in writing the subscripts will not inconvenience users of the chart. The meaning of the coefficient of part correlation can be made clear by comparing it with the partial correlation coefficient. Partial correlation measures the concomitant variation of the dependent and one independent variable in a hypothetical universe with the influence of the other independent variables removed from both, while part correlation leaves all the variation within the independent factor and only adjusts the dependent. The coefficient of part correlation, ${}_1r_{0\cdot23}$, or ${}_{01}r_{23}$, is literally the coefficient of correlation between

$$X_1 \text{ and } (X_0-b_{02\cdot13}X_2-b_{03\cdot12}X_3),$$

---

[1] For a comparative evaluation of these and other methods, see

H. D. Griffin, "On Partial Correlation vs. Partial Regression for Obtaining the Multiple Regression Equation," *Journal of Educational Psychology*, January, 1931, Vol. XXII, pp. 35–44.

H. D. Griffin, "Fundamental Formulas for the Doolittle Method Using Zero-Order Correlation Coefficients," *Annals of Mathematical Statistics*, May, 1931, Vol. II, pp. 150–153.

[2] D. R. G. Cowan, "A Note on the Coefficient of Part Correlation and of Correlation of a Dependent Variable with All but One of a Group of Other Variables," this Journal, June, 1932, Vol. XXVII, pp. 177–179.

[3] B. B. Smith, *Correlation Theory and Method Applied to Agricultural Research*, Washington, Bureau of Agricultural Research, United States Department of Agriculture, August, 1926, pp. 57–60.

M. M. B. Ezekiel, *Methods of Correlation Analysis*, New York, John Wiley & Sons, 1930, pp. 181–84, 370–80.

while the partial correlation coefficient, $r_{10\cdot 23}$, or $r_{01\cdot 23}$, is the coefficient of correlation between

$$(X_1 - b_{12\cdot 3}X_2 - b_{13\cdot 2}X_3) \text{ and } (X_0 - b_{02\cdot 3}X_2 - b_{03\cdot 2}X_3).$$

The derivation of the formula for the coefficient of part correlation is given in Ezekiel, *op. cit.*, pp. 379–380.

Smith writes the formula for the coefficient of part correlation thus

$${}_1r^2_{0\cdot 23} = \frac{1}{1 + \dfrac{\sigma_0^2(1 - R^2_{0\cdot 123})}{b^2_{01\cdot 23}\sigma_1^2}}.$$

Ezekiel prefers the formula

$${}_{01}r^2_{23} = \frac{b^2_{01\cdot 23}\ \sigma_1^2}{b^2_{01\cdot 23}\ \sigma_1^2 + \sigma_0^2(1 - R^2_{0\cdot 123})}.$$

Cowan used Ezekiel's form in constructing the formula which he suggests, for as $\beta_{01\cdot 23} = b_{01\cdot 23}\sigma_1/\sigma_2$, so

$${}_{01}r^2_{23} = \frac{\beta^2_{01\cdot 23}}{\beta^2_{01\cdot 23} + (1 - R_{0\cdot 123})}.$$

The present writer working on the problem in the fall of 1929, prior to the publication of Ezekiel's book, constructed his nomogram on Smith's version. Therefore, the formulas on the accompanying chart are written as

$${}_1r_{0\cdot 23} = \sqrt{\frac{1}{1 + \dfrac{1 - R^2_{0\cdot 123}}{\beta^2_{01\cdot 23}}}} \text{ and}$$

$${}_1r^2_{0\cdot 23} = \frac{1}{1 + \dfrac{1 - R^2_{0\cdot 123}}{\beta^2_{01\cdot 23}}},$$

which may be generalized as follows:

$${}_1r_0.{}^2_{23}\ .\ .\ .\ n = \frac{1}{1 + \dfrac{1 - R_0{}^2._{123}\ .\ .\ .\ n}{\beta^2_{01\cdot 23}\ .\ .\ .\ n}} = {}_{01}r^2{}_{23}\ .\ .\ .\ n$$

$${}_2r_0.{}^2_{13}\ .\ .\ .\ n = \frac{1}{1 + \dfrac{1 - R_0.{}^2_{123}\ .\ .\ .\ n}{\beta^2_{02\cdot 13}\ .\ .\ .\ n}} = {}_{02}r^2{}_{13}\ .\ .\ .\ n$$

$${}_3r_0.{}^2_{12}\ .\ .\ .\ n = \frac{1}{1 + \dfrac{1 - R_0.{}^2_{123}\ .\ .\ .\ n}{\beta^2_{03\cdot 12}\ .\ .\ .\ n}} = {}_{03}r^2{}_{12}\ .\ .\ .\ n$$

etc.

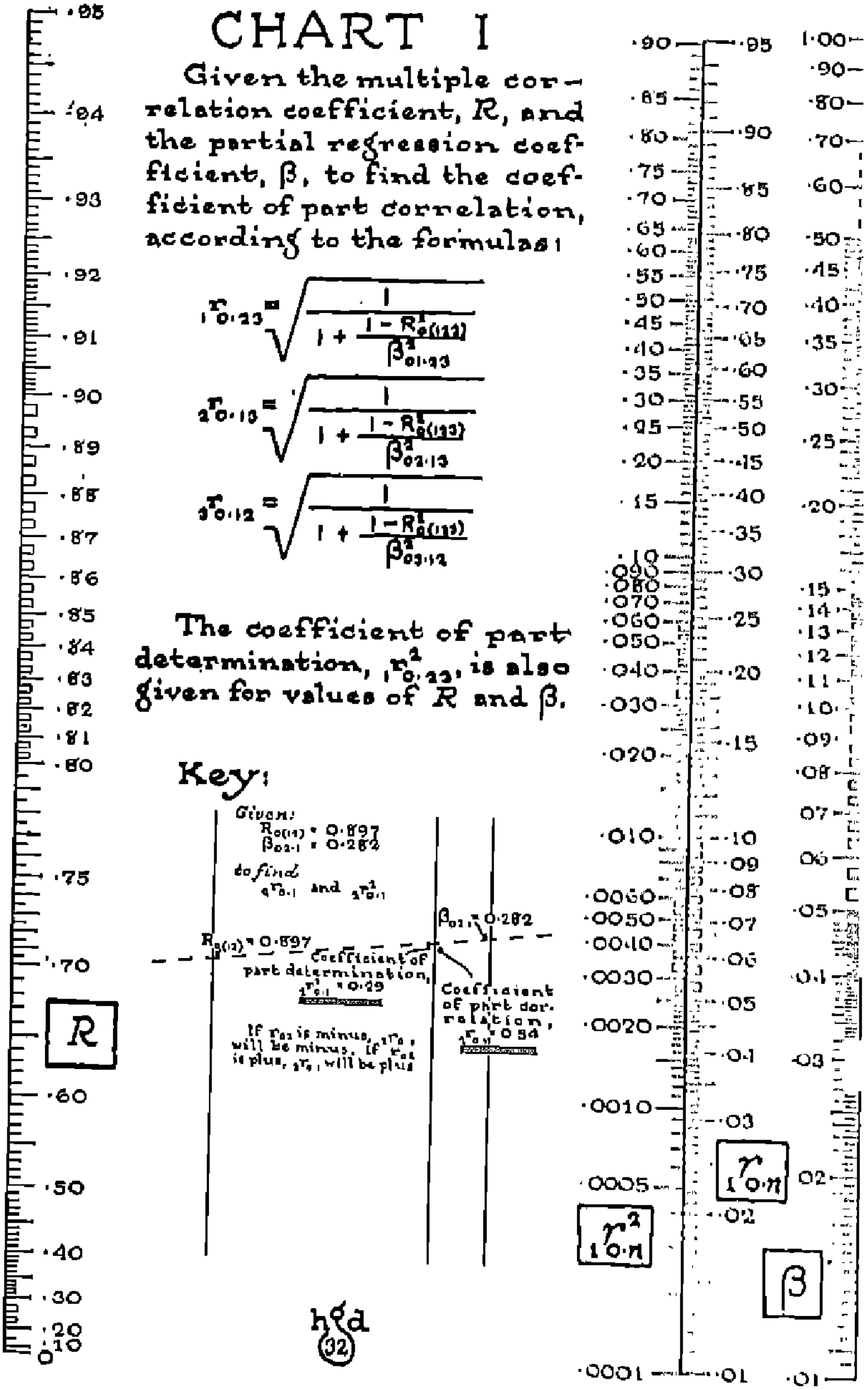


CHART I

Given the multiple correlation coefficient, R, and the partial regression coefficient, β, to find the coefficient of part correlation, according to the formulas:

$$_1r_{0\cdot23} = \sqrt{\frac{1}{1+\frac{1-R^2_{0(123)}}{\beta^2_{01\cdot23}}}}$$

$$_2r_{0\cdot13} = \sqrt{\frac{1}{1+\frac{1-R^2_{0(123)}}{\beta^2_{02\cdot13}}}}$$

$$_3r_{0\cdot12} = \sqrt{\frac{1}{1+\frac{1-R^2_{0(123)}}{\beta^2_{03\cdot12}}}}$$

The coefficient of part determination, $_1r^2_{0\cdot23}$, is also given for values of R and β.

Key:

Given:
$R_{0(12)} = 0.897$
$\beta_{02\cdot1} = 0.282$

to find
$_2r_{0\cdot1}$ and $_2r^2_{0\cdot1}$

$R_{0(12)} = 0.897$

$\beta_{02\cdot1} = 0.282$

Coefficient of part determination, $_2r^2_{0\cdot1} = 0.29$

Coefficient of part correlation, $_2r_{0\cdot1} = 0.54$

If r_{02} is minus, $_2r_{0\cdot1}$ will be minus. If r_{02} is plus, $_2r_{0\cdot1}$ will be plus

The first subscript to the right of r in the formulas on the chart designates the dependent variable (or criterion), the subscripts following the period denote the independent variables whose functions have been subtracted from the dependent variable, and the subscript to the left of r is the remaining independent which in itself is unadjusted but is to be correlated with the adjusted dependent.

The squared form of a coefficient of part correlation may be considered as a coefficient of part determination. Thus, ${}_{01}r^2_{23}$ or ${}_{1}r^2_{0.23}$ may be explained as measuring the per cent variance attributable to X_1 which remains in X_0 after the net effects of the other variables are taken into account.[1]

This nomographic chart will compute the coefficients of part correlation and the coefficients of part determination in problems of any number of variables. The writer suggests that a straight line scratched by a needle on the under-surface of a strip of celluloid makes the most satisfactory straight-edge to use with it.

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[1] Ezekiel, *op. cit.*, p. 183.

CENSUS OF DISTRIBUTION [1]

By Robert J. McFall

The new Census of Distribution, taken as a part of the Fifteenth Decennial Census, is essentially a census of the merchandising trades.

In covering the retail and wholesale trades, information was gathered on the organization and operating expense of each business establishment covered, the net sales and stocks.

The principal inquiries on the schedules were as follows:

Description of establishment
Description of business
Proprietors and firm members
Number of employees, and salaries and wages
Rent paid
Interest paid
All other expenses
Stocks on hand for sale
Net sales of merchandise and products
Credit sales
Commodity sales

In addition, the various schedules carried special inquiries relative to the field covered, such as repair and service operations, sales of cream and milk, slaughter of meat animals, etc.

An establishment-to-establishment canvass was made by special corps of census-takers in the larger cities and by the regular enumerators in places of less than 10,000 inhabitants.

For the retail trade there were four main schedules—viz., one for food stores, another for drug stores, the third for other stores and a fourth which was a short form on which all small retail establishments reported. For the wholesale trade there were two schedules—viz., one for food dealers, and the other for other wholesale dealers of all kinds.

A combined schedule for both retail and wholesale was used in covering the automotive trades. In the small towns and rural communities, an omnibus schedule was used which covered both retail and wholesale establishments.

As a matter of organization the census of construction was taken as a branch of the Census of Distribution.

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[1] Substituted for the usual Progress of the Census report by Dr. J. A. Hill.

For census purposes, the term "retailer" includes all establishments selling goods at retail direct to consumers. Thus restaurants are included, for their sales are to the general public as consumers.

Stores selling feed and supplies to farmers, and selling hardware to builders, are also included, because they conduct their businesses in the manner of retailers and are generally considered to be such. All stores are classified in accordance with the description or designation commonly used by the trade and by the public-grocery stores, drug stores, etc.

A wholesale establishment, for purposes of the census, includes the entire non-retail field among the merchandising concerns. Hence wholesale trade, as defined for census purposes, embraces all establishments engaged in the purchase and sale, or distribution of goods on a wholesale basis. In addition to wholesalers of the conventional type, the census covers all establishments performing the wholesale function in business. It includes assemblers and country buyers of farm products, such as elevators, produce buyers, coöperative marketing associations, etc.; likewise brokers, commission merchants, selling agents, etc.

In order to make the information available as quickly as possible, the statistics for the retail and wholesale trades were first given out in preliminary form for cities; the retail reports being issued for all cities of 10,000 population and more, the wholesale for cities of 100,000 and more. Preliminary figures for states and other divisions, by kind of business, were also made available in United States Summaries for these trades.

Complete and final statistics are now being issued in reports for states. These reports have now been issued for many states, and the others are in the process of publication; and will all be available within a short while.

The Retail Reports.—The items of information include number of stores; the number of employees, distinguishing full time and part time; total pay roll, distinguishing payments to full time employees and to part time; the total net sales; value of stock on hand at the end of the year; number of proprietors and firm members not on pay roll; expenses, showing separately total pay roll, wage value of proprietors' services, and rent paid for leased premises, but not including the cost of merchandise sold.

The number of stores and annual net sales are classified by kind of store, distinguishing grocery stores, furniture stores, dry goods stores, etc.; also by type of operation, distinguishing single store independents, two and three store independents, local chains, sectional chains, and national chains.

There is also a classification by size of business, distinguishing stores with sales from $100,000 to $199,999, from $50,000 to $99,999, etc., also a classification with reference to the percentage of business done on credit, distinguishing all-cash stores, stores doing from 1 to 10 per cent of sales on credit, from those doing from 11 to 20 per cent credit, and so on.

The reports include an analysis or breakdown of sales by commodities so far as the data could be obtained. The commodity coverage, as it is called, i.e. the percentage which the sales reported by commodities constitute of the total sales, varies widely in different kinds of stores. In the case of department stores, for instance, frequently 100 per cent of the sales were reported by commodities, whereas in other kinds of stores the commodity coverage might in some cases be much smaller.

Tables have been included in the reports showing what percentage the sales of any given commodity form of the total sales reported by commodities; and even where the commodity coverage is small it is believed that these percentages have significance and can be used as a basis for estimating the total sales of that commodity in the given class of stores. The Bureau has published a bulletin on the uses that can be made of the commodity data as here presented.

The number of stores and net sales by principal kinds of business are shown separately for each county and for each city or incorporated place of 1,000 population or over. Fuller detail is given for individual cities of 30,000 population or more.

The following is a list of the tables shown for the state as a whole:

Retail distribution, by kinds of business
Operating expenses—all retail stores
Seasonal employment characteristics
Sales by size of business
Retail distribution by types of operation
Retail distribution—17 kinds of business by types of operation
Sales classified according to degree of credit
Credit business
Receipts other than from the sale of merchandise
Merchandise manufactured, sales to other retailers, returned goods, and other related data
Legal forms of organization
Retail distribution by counties (including cities and towns of 1,000 population and over)
County distribution by kinds of business
Sales by commodities

The Wholesale Reports.—The items of information include number of establishments; number of employees; total salaries and wages; total expenses, including salaries and wages; cost value of stocks on hand at end of year; net sales, amount and per cent of total; credit sales, amount and per cent of net sales; sales at retail to ultimate consumers; sales to industrial consumers. These statistics are given by kind of business (automotive, hardware, dry goods and apparel, electrical, jewelry and optical goods, etc.); and by type of establishment (full-service and limited-service wholesalers, bulk tank stations, chain-store warehouses, district sales offices, etc.).

The number of establishments, number of employees, salaries and wages, total expenses and net sales are also given by character of organization, distinguishing individual proprietorships, partnerships, corporations, and coöperative associations.

The numbers of marketing units (single-unit, two-unit, up to 100 or more) are likewise shown, with the number of establishments, their net sales and total expenses (including salaries and wages) given by unit groups.

Employees engaged are distinguished as salesmen, executives, and all other employees.

Wholesale merchants proper, as distinguished from brokers, commission merchants, etc., are classified according to annual volume of net sales, and by kinds of business. Commodity sales and commodity coverage are shown in considerable detail.

Information in full detail is given for the state as a whole and for cities of 500,000 population and over and in less detail for smaller cities.

The following is a list of the tables shown for the state as a whole:

Summary of wholesale trade by principal kind of business classifications
Wholesalers only, by kinds of business
Wholesale trade, by kind of business
Wholesale trade, by type of establishment
Number of establishments, by type and kind of business
Net sales, by type of wholesale establishment and kind of business
Total expenses, by type of wholesale establishment and kind of business
Summary of wholesale trade, by character of organization
Wholesale trade, by the number of marketing units and kind of business
Employees engaged in wholesale trade, by kinds of business
Classification of wholesale merchants according to net sales, by kind of business

Number of establishments, by kind of business

Commodity sales, by kind of business and type of establishment.

In addition to the state reports, the Distribution Division is issuing special and trade studies covering the principal phases of the census. Some of these reports are already available, and the others are either in the process of printing or preparation.

The retail and wholesale reports for states, together with United States Summaries for each trade, are to be assembled in the final quarto volumes of the Census of Distribution. These volumes will contain all the basic statistics on these trades, by geographic divisions of the United States.

A METHOD OF CALCULATING WEEKLY SEASONAL INDEXES

By Leroy M. Piser, *Federal Reserve Bank of New York*

A growing realization that monthly data do not give a sufficiently current portrayal of the changing economic situation has led to an increasing interest in weekly data. For the satisfactory interpretation of such figures it is often necessary to adjust for seasonal variations. The weekly measurement of seasonal fluctuations, however, involves two important difficulties. First, as weekly data are available for relatively few series and generally over only a short period of time, the weekly indexes should be considered as supplementary to the monthly indexes and should accordingly check with them. Second, it is necessary in a number of series that the seasonal index make allowance for the variations from year to year in the date of each week. In the case of the amount of reserve bank credit outstanding, for example, there is a measurable difference whether the second week of the year ends on

TABLE I
CALCULATION OF RATIOS FOR WEEKLY SEASONAL INDEX ON COMBINED AMOUNT OF RESERVE BANK CREDIT AND MONETARY GOLD STOCK IN THE UNITED STATES

Week ended		(1) Average daily data in millions of dollars	(2) Distribution of monthly adjusted data	(3) Ratio column (1) ÷ column (2)
1922				
January	7	5,168	4,983*	103.7
	14	5,004	4,983*	100.4
	21	4,944	4,983**	99.2
	28	4,914	4,989	98.5
February	4	4,941	4,993	99.0
	11	4,958	4,997	99.2
	18	4,932	5,002**	98.6
	25	4,903	5,002	98.0
March	4	4,951	5,003	99.0
	11	4,930	5,003	98.5
	18	4,959	5,003**	99.1
	25	4,923	5,004	98.4
April	1	4,952	5,005	98.9
	8	4,966	5,005	99.2
	15	4,985	5,006**	99.6
	22	4,970	5,014	99.1
	29	4,942	5,022	98.4
May	6	5,002	5,031	99.4
	13	4,989	5,039	99.0
	20	4,970	5,047**	98.5
	27	4,955	5,041	98.3
June	3	4,980	5,035	98.9
	10	4,976	5,029	98.9
	17	4,988	5,023**	99.3
	24	4,925	5,022†	98.1

* Calculated partly from adjusted figure for December, 1921, which is not shown.
** Monthly adjusted figure.
† Calculated partly from adjusted figure for July, 1922, which is not shown.

Number of establishments, by kind of business
Commodity sales, by kind of business and type of establishment.

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A growing realization that monthly data do not give a sufficiently current portrayal of the changing economic situation has led to an increasing interest in weekly data. For the satisfactory interpretation of such figures it is often necessary to adjust for seasonal variations. The weekly measurement of seasonal fluctuations, however, involves two important difficulties. First, as weekly data are available for relatively few series and generally over only a short period of time, the weekly indexes should be considered as supplementary to the monthly indexes and should accordingly check with them. Second, it is necessary in a number of series that the seasonal index make allowance for the variations from year to year in the date of each week. In the case of the amount of reserve bank credit outstanding, for example, there is a measurable difference whether the second week of the year ends on

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	15	4,985	5,006**	99.6
	22	4,970	5,014	99.1
	29	4,942	5,022	98.4
May	6	5,002	5,031	99.4
	13	4,980	5,030	99.0
	20	4,970	5,047**	98.5
	27	4,955	5,041	98.3
June	3	4,980	5,035	98.9
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January 8 or on January 9, and the difference between January 8 and January 11 amounts to nearly 20 per cent of the amplitude of the seasonal index.

The method of computing weekly seasonal indexes which has been used at this bank for a number of years obviates both of these difficulties. The weekly index is derived from the monthly index and consequently checks exactly with it. Moreover, the method may be used to obtain an index either with or without allowance for the varying date of each week.

The accompanying tables illustrate the steps essential to the calculation of a weekly seasonal index on the combined amount of reserve bank credit and monetary gold stock in this country. After the monthly data have been corrected for monthly seasonal variations by a standard method, each adjusted figure is placed opposite the week which includes the fifteenth of that month. This is illustrated in Table I, column 2.[1] A weekly series without seasonal influence is obtained for the intervening weeks of each month by straight-line interpolation between the monthly adjusted data. The ratio between each actual weekly figure and the corresponding adjusted figure is calculated in

TABLE II

CALCULATION OF WEEKLY SEASONAL INDEX ON COMBINED AMOUNT OF RESERVE BANK CREDIT AND MONETARY GOLD STOCK IN THE UNITED STATES

Week ended		(1) Ratios computed in Table I	(2) Average of daily ratios	(3) Moving median of column (2)	(4) Index
January	*Year*				
1	1927	104.9	104.9	104.8*	104.9
2	1928	104.8	104.8	104.8*	104.8
3	1925	104.6	104.6	104.6	104.7
4	1930	104.5	104.5	104.5	104.5
5	1924 1929	104.1 104.2	104.2	104.2	104.2
6	1923	103.7	103.7	103.8	103.8
7	1922 1928	103.7 103.9	103.8	103.7	103.6
8	1927	103.2	103.2	103.2	103.2
9	1926	102.5	102.5	102.6	102.5
10	1925	102.4	102.4	102.4	102.4
11	1930	101.6	101.5	101.7	101.7
12	1924 1929	101.1 101.3	101.2	101.5	101.5
13	1923	101.7	101.7	101.2	101.2
14	1922 1928	100.4 100.9	100.7	100.7	100.7
15	1927	100.4	100.4	100.4	100.4
16	1926	100.1	100.1	100.1	100.2
17	1925	100.1	100.1	100.1	100.0
18	1930	99.7	99.7	99.7	99.7
19	1924 1929	99.5 99.9	99.7	99.7**	99.6
20	1923	99.4	99.4	99.4**	99.5

* Calculated partly from December data, which are not shown.
** Calculated partly from later January data, which are not shown.

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[1] Had the monthly deseasonalised data shown marked irregularity their fluctuations would have been reduced by the computation of a moving average.

column 3; these ratios reflect the seasonal element and such irregularities as are present in the data.

If no allowance were to be made for year to year variations in the date of each week, the ratios would be tabulated by weeks, an average of the middle items computed, and the total adjusted to 5,200. Since it is necessary in the example given, however, to allow for the changing date of each week, the ratios are tabulated according to the day on which the week ends, as is illustrated in Table II, column 1. When two ratios appear for any day, they are averaged in column 2; if no ratio had been available for a certain day, a figure would have been interpolated from the preceding and following days. The fluctuations of these daily ratios are smoothed in column 3 by calculating the median of a moving five day period, placing the median opposite the third day of each period. In column 4, any remaining irregularities are eliminated by inspection, and the total is adjusted to 36,500. The seasonal indexes for any year are obtained from column 4; for example, the index for the first week of 1932, which ended on January 2, is 104.8, and for the second week is 102.5.

AN OPEN LETTER

Editor, Journal of the American Statistical Association:

Sir: The first sentence of the review of Woods and Russell's *Introduction to Medical Statistics* by a Mr. Kopf runs:

> In the preface Dr. Major Greenwood declares that the young medical men and women coming under instruction in the Division of Epidemiology and Vital Statistics of the London School of Hygiene and Tropical Medicine are taught to carry out with facility and confidence the statistical operations which a Medical Officer of Health must supervise.

Why Mr. Kopf should put so silly a brag into my mouth I do not know. What I actually said was that

> We hope, however, that we may give sufficient instruction to enable every student to understand and carry out the statistical operations which a Medical Officer of Health *must* supervise and to encourage many students to extend their knowledge. We believe that when a student has acquired facility and confidence in carrying out the simpler operations of statistical analysis, he will usually wish to go further.

No experienced teacher is fool enough—to put it no higher— to promise 100 per cent of successes. How on earth, for example, could I, or any other teacher, in a much longer course than we give at the London School of Hygiene expect to teach Mr. Kopf to make accurate statements? I see that, according to him, "on page 35 the definition of infant mortality is clearly wrong." I turn to page 35 and read "Infant mortality is generally measured as the deaths under 1 year per 1,000 births in the same year." This is not a definition of anything but an accurate statement of the practice of the General Register Office of England and Wales which it was Woods and Russell's business to explain to the students, just as it was their business to point out (on the following page) why the method of measurement was faulty.

Whether this book is or is not of educational value, is clearly a matter on which two opinions are possible. I do not think two opinions are possible as to the impropriety of the statements to which I have called attention.

I am,

Faithfully yours,

M. Greenwood

UNEMPLOYMENT—ITS ORIGIN AND ITS ELIMINATION

A dinner meeting of the American Statistical Association was held on Tuesday evening, March 29, 1932, at the Peg Woffington Grill Room, 413 West 23rd Street, New York City. Seventy-seven persons were in attendance. Dr. John B. Andrews, Secretary of the American Association for Labor Legislation acted as Presiding Officer. The general topic for discussion was "Unemployment—Its Origin and Its Elimination."

The first speaker of the evening was Dr. Arthur D. Gayer of Columbia University and the National Bureau of Economic Research. He spoke on "Public

Works as a Stabilizer of Employment.'' He pointed out that the proposal to use public works as a remedial measure is not new, having been advocated as long ago as 1909 in the British Poor Law report. The principle was also endorsed in 1923 by the President's Conference on Unemployment.

Because of the widespread discussion of the subject, it is often erroneously assumed that the volume of public works has been increased greatly during the present depression. As a matter of fact, this volume in 1930 was only a trifle greater than in 1929 and was below the level for 1927 and 1928. There would indeed have been a decline in 1930 had that year not been devoted largely to finishing up undertakings begun in 1929 when prosperity was still with us. True, Federal public works were more extensive in 1930 than previously, but state and local undertakings were curtailed. Further large declines in the latter lines also occurred in 1931.

If public works are to be used to stabilize the cycle, their volume, evidently, should be made to oscillate in a direction opposite to the ups and downs of private industry. In too many cases, what actually happens is that borrowing for public works in good times increases the volume of credit inflation and accentuates the boom.

One must not assume that all public works are susceptible of advancement or retardation. However, perhaps 50 per cent of the volume could, with advantage, be shifted from times of prosperity to times of depression. Although this volume would seem to be very small as compared to the deficiency in industry in a depression like the existing one, it is believed that the indirect effects of expanding employment might be sufficient to build up a volume of activity large enough to be of real moment. The question which has not yet been finally settled is the exact time at which public works ought to be centered in order to secure the best results. Some believe they should be speeded up early in the decline, others that concentration should be late in the depression. Little of a remedial nature can be accomplished unless plans are completed long in advance, for, normally, a considerable period elapses between the initiation of a project and the actual spending of the money for public works. The Federal Stabilization Board expects to make plans for six years in advance. It is hoped that states and municipalities will establish similar boards to perform like functions.

The recently observed curtailment in public construction has been primarily due to the fiscal difficulties under which the various branches of the Government have been laboring. Many hold that, under such circumstances, a public building program is not feasible. Actually, however, the probabilities are that, if the Federal Government were now to borrow five billion dollars for public construction, business would be greatly stimulated and existing taxes would increase to such an extent that the additional revenue would more than cover the interest on the new bonds issued. Many fear that expansion of public works would cause great waste of public funds. If properly managed, such enterprises would be conducted on a basis of expense lower than would be possible in boom times. At any rate, the Nation would get some return from the work of men engaged in construction. Now, we are compelled to support the unemployed by charitable measures, and the public gets nothing from them in return.

The second speaker of the evening was Beulah Amidon, Associate Editor of *The Survey* and *The Survey Graphic.* She dealt with "The Employer's Part in Stabilization." She began by pointing out that, before much headway can be made in stabilization through the action of the employer, the employer must be made to take an interest in the matter. A great deal may be accomplished when employers in general put as much energy into stabilizing production and hence employment as they now devote to problems of production, selling, and finance.

Numerous methods of cutting off the peaks and filling in the troughs have been found feasible. Some employers have found new uses for old products or have stimulated the use of these products at seasons in which there was formerly no demand. Other employers have found it profitable to produce special articles for delivery in seasons when their main line of business is dull. In some concerns production is budgeted so that it goes on regularly even though the demand for the products fluctuates. This plan works well when the product is non-perishable and easily stored. Attempts to stabilize production by increasing sales pressure in dull times, while helpful in the seasonal slumps of "normal" conditions, are of little use in an extended depression. A stabilization program is often difficult to work out and, in some respects, may prove costly. On the other hand, by reducing labor turnover, it represents an economy for the employer. Furthermore, unit cost of production is cut through assuring the worker of a steady job. He is not under the temptation to "stretch out" his work by loafing, breakage and so on; and he is willing to work at a lower wage rate when he is sure of a steady and hence higher annual income.

Many employers who have not been able to keep production steady have tried to "spread work," giving the whole force part time, instead of keeping a reduced force full time. When carried too far, this procedure may reduce wages so far as to break down living standards.

Experience indicates that employers can do much to lessen the hardships of technological change. They may reduce such unemployment by making the changes in planned and orderly fashion. They may assist employees to find new work or train them for new positions in the plant. Some concerns give a dismissal wage to employees laid off through no fault of their own. Employers cannot, however, eliminate all difficulties arising from technical change.

In dealing with unemployment, the far-sighted employer encourages two lines of attack under public control. The first is adequate public employment service to help workers find new positions promptly. A further step is to provide sizable reserves out of which some compensation may be paid an unemployed worker, just as accident compensation is paid an injured worker.

Wisconsin has recently passed a law making the accumulation of such reserves compulsory. The New York State Legislative Committee has endorsed the idea in principle but, as yet, no action has been taken. All the measures mentioned, while useful, are palliatives. They treat symptoms, not underlying causes.

Obviously, something more far-reaching is needed. A picture of our present chaos shows, on one side, producers with vast supplies which they are unable to sell; on the other, consumers in need of these supplies and unable to purchase them. Some central agency to coördinate supply and demand is clearly necessary.

The third speaker was Willford I. King, Professor of Economics at New York University, who discussed the possibility of remedying unemployment through coöperation of employers and employees. He began by pointing out the fallacious nature of the theory that, under our present system, employers bear the risk to industry caused by the business cycle while employees receive steady wages and hence take little risk. As a matter of fact, whenever depression comes, either wage earners are laid off in great numbers or put on short time. Wage rates per piece or per hour are, indeed, maintained, but this is far from saying that weekly earnings are not cut sharply.

In the speaker's opinion, the common belief that it is desirable to maintain wage rates on an even keel during prosperity and depression is extremely unfortunate, for this practice of wage maintenance makes unemployment inevitable. Labor is subject to the laws of supply and demand just as fully as are other commodities. When the demand for other commodities shrinks, and, at the same time, prospective sellers maintain their holding prices unchanged, evidently the volume of sales diminishes. This situation explains fully the origin of unemployment.

When depression appears, the curve representing the demand for labor shifts downward and to the left, for employers are no longer able to sell their products at the prices previously prevailing. Since wage earners in general demand the same rates of pay per hour or per piece as formerly, it evidently follows that the volume of sales of labor will decline; in other words, part of the labor force will be unemployed.

There are only two possible ways of remedying unemployment: first, by strengthening the demand for labor; second, by reducing the subjective prices which laborers place upon their own labor. In a cycle in which there is no downward trend in the general price level, unemployment finally disappears because the demand curve for labor shifts upward and to the right. In the present depression, the general price level seems to have a sharp downward trend. It appears, therefore, that the only possible method of assuring a market for the total labor supply is for laborers to reduce their subjective wage rates. All devices, such as the dole, unemployment insurance, and the like, which tend to interfere with these principles of adjustment, prevent the elimination of unemployment and the recovery of business.

The speaker suggested that, if employers and employees both eliminated from their minds the idea that wage maintenance is desirable, it would be very easy to do away with unemployment, especially in those industries turning out products the demand for which is elastic. In such industries, the employers might well agree with their employees that the prices of products would be cut to whatever extent might prove necessary in order to keep the plant operating full time. To make this program possible, it would obviously be essential to slash both wages and salaries—perhaps very heavily. Acquiescence of the employee in a program of this sort should be secured by promising that dividends would be reduced in the same proportion as wages and salaries and that, whenever dividends were again increased, wages and salaries would also be increased by a like percentage.

Instead of reducing the hours of labor per week, the employer should lengthen hours so that the weekly earnings of the employees would be sufficient to maintain them in comfort. The satisfactory operation of such a plan would be made much more probable if, during prosperous times, heavy reserves were laid aside to be used to subsidize both wages and dividends when depression appeared.

The last regular speaker on the program was George Soule, Editor of the *New Republic*, who spoke on "The Elimination of the Cycle as a Means of Lessening Unemployment."

Mr. Soule began by raising the query as to whether the plan proposed by the previous speaker for eliminating unemployment would work unless rents and interest charges, as well as dividends and wages, were reduced during depression periods. Mr. Soule believed that, as a matter of fact, it is not feasible to eliminate unemployment unless it is possible to eliminate the cycle itself, a result which does not seem possible unless we can install a system of planning and control.

The fundamental cause of the present depression appears to be that, during the last few years, there has developed a lack of balance between the volume of industrial equipment produced and the demand for the products of industry. Income has not been distributed in the proper degree. Industrial production and profits have advanced rapidly while wages and farm incomes have increased but slowly. The result has been a concentration of a large proportion of the income of the Nation in the hands of a small proportion of the population. The recipients of large incomes have been unable to devise methods of consuming their incomes in full and hence they have been almost compelled to invest in securities. This invested money has resulted in great expansion of productive plants and also in the volume of credit, but the demand for the products of industry has failed to keep pace with plant expansion.

If we are to avoid similar catastrophes in the future, it is imperative that we have a chance to plan and control the distribution of income and credit. Strong unions in all industries should be encouraged to push up all wages as high as the marginal concerns could afford to pay, and the higher cost concerns should gradually be eliminated. Farm incomes should be increased. Productive equipment should not be allowed to outrun the demands of the consumer. The supply of credit should be adjusted to the needs of business. In certain industries, such as house construction, the prices of the products should be lowered. The same would be true in the case of the output of public utilities. Utilization of land should be studied carefully and sub-marginal farm land should be eliminated from production. The tax programs and the budgets of various governmental organizations should be scientifically controlled. Foreign investments should be supervised. Concentration of income in the hands of the rich should be lessened.

The Swope plan for control of industry is wrong in that it proposes to put control into the hands of trade associations. These associations would proceed to reduce output—exactly the reverse of what is necessary. Control of industry should be in the hands of a Board of Experts representing the Nation as a whole and not merely an interested group. Industry should be consolidated in large units. In some cases these units should be publicly owned and in some cases public supervision might be better. In many cases products could be standardized and the price-spread between producer and consumer thereby lessened. Nation-wide labor exchanges should be established. Unemployment insurance should be provided to prevent suffering among men who are thrown out of work.

The program just outlined is the minimum basis upon which it is possible to eliminate unemployment.

Several persons, speaking from the floor, raised various questions and made comments along a number of lines. One speaker pointed out that unemployment is an international and not merely a national problem and that it is a mistake, therefore, to consider international relations as unimportant.

Barnabas Bryan stated that the fact that unemployment is a resultant of the wage rate and the demand for labor is readily shown by a mathematical computation. If the United States Bureau of Labor Statistics' *Index of the Prices of Commodities at Wholesale* is divided by the average wage of all railway employees —a wage comprehensive enough to show the general level of wages in the United States—and if the quotients derived by this process of division are plotted, it will be found that the curve follows very closely that representing the volume of employment in the United States. Clearly, then, if one wishes to eliminate unemployment, one must vary the wage rate to correspond with changes in the commodity price level.

Leifur Magnusson mentioned the fact that the diversity in the movements of wholesale and retail prices during recent years has been less than has been the case in the past.

Several speakers brought out the fact that, if industry were to build up huge reserve funds to cover periods of depression, these reserve funds would have to be held in the form of cash or marketable securities. If kept in the latter form, the selling of these securities would presumably cause a great decline in their prices and would, therefore, result in a heavy loss to the fund. In answer to this contention it was pointed out that, if the reserve fund were held in high-grade government securities, such as Federal Reserve Bonds, money might be secured by borrowing on these bonds rather than by throwing them on the market.

The latter part of the discussion ranged around the fact that the charges required to maintain unemployment reserves would necessarily constitute a burden upon wages and that the wage earner should not be penalized when he moved from employment in one concern to employment in another concern.

WILLFORD I. KING

FORECASTING METHODS SUCCESSFULLY USED SINCE 1928

A dinner meeting of the American Statistical Association was held on Tuesday evening, April 26, 1932, in the Hotel Governor Clinton, 31st Street and Seventh Avenue, New York City. Two hundred and thirty-three persons were present. Dr. Edmund E. Day, Director for the Social Sciences for the Rockefeller Foundation, presided. The general topic for discussion was "Forecasting Methods Successfully Used Since 1928."

The first speaker of the evening was Dr. Lionel D. Edie, of the American Capital Corporation. He began by pointing out that success in forecasting either the bull market of 1925–1929 or the bear market of 1929–1932 does not demonstrate that the method used by the forecaster possessed any particular merit. In all probability, success was due merely to good fortune.

Before 1929, forecasters relied mainly upon mechanistic systems. The essence of such a system is that it can be communicated to another person who can then proceed to use the system successfully. Such systems are supposed to eliminate the judgment factor. Dr. Edie expressed the view that such methods lead only to futility, for judgment is the really essential feature of every successful forecasting system which is based upon anything other than pure luck.

The speaker illustrated his thesis by citing his own experience in regard to his prediction early in 1930 that commodity prices were destined to fall drastically. He made this forecast because, by talking with the leading central bankers of Europe and America, he had discovered that their mental attitude was such as to lead to deflation. It would be extremely difficult to arrange any mechanical system which would take account of these mental attitudes. Nevertheless, without understanding the philosophies of these bankers, one could have told nothing of what was going to happen.

Dr. Edie stated that a year ago he had predicted that deflation would continue until leaders of the inflationist school gained political control and forced the central banks to increase the supply of money and credit. The deflationists have engineered the depression to date. Now, in the United States, the "wild men of the west" are springing into the saddle and they will strive to direct the course of prices in the future. It is impossible to guess how effectively they can exercise their power.

A few years ago, statisticians everywhere were much interested in constructing very broad composite index numbers, believing that the breadth of these numbers would make them helpful in forecasting. The present tendency is to substitute the atomistic for the inclusive method—for example, if we wish to forecast the volume of steel production, we now attempt to measure each separate item in the demand for steel.

Another method of forecasting which has proven wholly futile is that basing its conclusions upon the composite opinion of the "best" minds. All that this method accomplishes is to warp the judgment of the statistician making the forecast, for the "best" minds usually are as badly informed about the outlook as the man on the street. To succeed, the statistician's judgment should be influenced as little as possible by popular emotion.

The second speaker of the evening was Paul Clay, Investment Counselor. He began by pointing out that white-haired forecasters are rare. He ascribed this situation largely to the fact that, every few years, industry passes from one era to another. In these different eras, different relations between industries and prices tend to prevail. Between 1863 and the present time, we have passed through no less than six such eras.

Mr. Clay stated that, after years of research concerning the cyclical movements of prices, he had built up five rules which he believed to be dependable. Between

1928 and 1931, however, all five of these broke down. The present indications are that this breakdown was caused by the fact that the rules were applicable to some eras but not to others.

Mr. Clay stated that he now felt that, in the past, he had underestimated the importance of the New York Stock Market itself in the industrial and financial affairs of the United States, and even of the world. This market, in fact, constitutes a secondary central bank for the United States, for it is the center at which all values can be liquidated on demand. The movements of the stock market represent the net result of the industry of the United States and a considerable proportion of the rest of the civilized world. Because of this conclusion, Mr. Clay has been led to construct a new index similar, in general, to the Dow theory, but not based upon the Dow methods. This index number he calls a psycho-technical index. It contains five principal elements:

1. A volume index number made by giving the sign of the price movement to the daily volumes, and accumulating the plus and minus movements.
2. Price movements of the twenty stocks having the largest volume of sales on a given day. This item is designed to cover pool activities.
3. A time index number made by adding 1 to the index for each upward day, and subtracting 1 for each minus day.
4. Resistance ratios designed to show the difference between liquidation and short sales.
5. The velocity of movements of stock prices.

The psycho-technical index built out of these five elements looks much like a price chart with the false movements eliminated.

It has the very distinct merit of often moving contrary to the course of the market itself. This index is not used independently, but rather in conjunction with the economic indexes which formerly constituted the chief reliance of Mr. Clay. In most cases, the indications of this mechanical barometer have proven more valuable than any conclusions arrived at on the basis of personal judgment.

The third speaker of the evening was Dr. Lewis H. Haney, of the Bureau of Business Research of New York University. He took the position that business forecasts have hitherto depended entirely too much upon statistical technique and have given too little consideration to the laws of economics. He felt that, though different eras might exist, economic laws ruled equally well in all eras. What the forecaster really needs is an abundance of statistical information and thorough training in economic principles. Unfortunately, in recent years, because of the vogue of "institutional economics" and "business economics," it has been more and more difficult to secure such training. Institutionalism is negative rather than positive in its attitude. It stresses description and exceptions to economic laws rather than the laws themselves. It tends to be "normative." Under the circumstances, the student is not sufficiently trained in positive economic principles. The weakness of business economics is that it gives too little weight to principles and too much weight to statistical facts. It has overemphasized the use of logarithmic charts and computed trends. These devices often mislead their makers.

To forecast successfully, one must analyze the facts in detail. It is, for example, important to keep track of the ratios of loans to deposits and of reserves to deposits. One must consider stocks of goods, production costs, trade conditions—both domestic and foreign—and everything else pertaining to the problem. It is important to observe relationships between supplies of raw material on hand and market activity. Margins between costs and selling prices are also extremely important.

Dr. Haney pointed out that, as long as business attempted to maintain wage rates at an abnormally high level, there was maladjustment, which was bearish—not bullish. He expressed the view that credit results from business and is not a cause of business. One cannot make more business by putting out more money. The maladjustments of 1929 have not yet been completed. Until this occurs, we cannot look for any sustained recovery.

He held further that empirical methods which depend upon precedent—upon the number of times that a certain relationship has recurred in the past—are inherently unsound. Scientific methods are the opposite of empirical methods. When these are used, there is no need of repeated demonstrations of their validity. One single test of a theory is ample. Economic principles can always be depended upon to hold true.

The last regular speaker on the program was Mr. James F. Hughes, of Charles D. Barney and Company. He explained that he was formerly a student of the relationships between economic activity and the stock market. He still believes that most of the relationships valid before 1928 will be found to hold true in the future. The big boom of 1929 must be considered an abnormality. Speculative enthusiasm caused the public in general to ignore the relationships dictated by common sense.

Even though the relationships between economic causes and market movements are fairly well established, the understanding of these relationships may be of little value to the speculator, for the time intervening between cause and effect is not sufficiently uniform to enable one to predict the turning point with precision, and, without this precision, it is not possible for the speculator to use the forecaster to make any considerable profits. Mr. Hughes stated, therefore, that he had been forced to depend more and more upon the action of the market itself as a guide to the location of turning points. In judging the action of the market, he depends not upon scientific reasoning but merely upon empirical rules based upon precedent. These empirical rules have proven very useful in assisting speculators to gain profits.

Mr. Hughes enumerated a number of the rules which he has found usually to hold good. He has observed that, after the course of the market has changed direction and covered a distance equal to 30 per cent or more of the movement just preceding, one must be on the lookout for a reversal in direction. Thus, after a selling climax in an active market, one should buy at once and sell as soon as the market has rallied by 40 per cent of the last break. When the market has risen for some time, and one of the speculative favorites collapses without any apparent reason, it is wise to sell out at once, for the rest of the market will probably follow.

Recently the market has been largely under the domination of seasonal forces, thus tending, for example, to decline in the second quarter of the year and to rise in the third. We may, therefore, look for a rally during the summer of this year. If business picks up, the rally may develop into a bull market, otherwise there will be another collapse. As a rule, the market rises between Christmas and New Year's. The market has habits because it is dominated by people and people have habits.

The remarks of the speakers were discussed briefly by Victor von Szeliski, of the Lehman Corporation. He pointed out that Dr. Edie was consistent in having no method to offer, inasmuch as Dr. Edie rejected the possibility of objective "indicators," and could recommend nothing better than using good judgment. This is a personal gift, uncommunicable by formula.

As one of the reasons why mechanical indicators so often failed, Mr. von Szeliski suggested that the interval, or time lag, between economic cause and effect was as a rule too small to permit the statistical detection of the cause before the effect followed. With reference to two of Dr. Haney's well-known indicators, the P/V line and the composite steel demand curve, he contended (1) That the former assumed a too simple relationship between P and V, viz., the regression coefficient of theoretical P on actual $V = 1$; thus, in periods of comparative price stability like 1921–1929, the P/V curve is in the main simply proportional to the reciprocal of V alone, and so "leads" the V curve by a half cycle of 1 to 2 years—a relationship observable between any cyclic curve and its inversion. (2) That the latter showed production of steel to have outrun demand for over a year: that this would have resulted in a tremendous inventory of finished steel products, which is not the case. Because steel production is almost wholly governed by specification, it is impossible for any such maladjustment as that found by Dr. Haney to occur. In point of fact, a carefully worked out demand composite does not show maladjustment. (There is maladjustment and inventory accumulation in the metal industry—at the mine, on the docks, in the hands of wholesale and retail dealers—but not where Dr. Haney finds it.)

Mr. von Szeliski denied any conflict between the rational economic approach of Drs. Edie and Haney, and the technical market methods of Hughes and Clay. The former tells *what*, the latter *when*. At least as far as stock speculation is concerned, the translation of our thought into *acts*, into buy and sell orders, must be governed by technical considerations. Economics may load the gun, select the mark, but technics pulls the trigger.

Willford I. King, *Secretary*

STATISTICAL METHODS IN ADVERTISING RESEARCH

A dinner meeting of the American Statistical Association was held on Tuesday evening, May 24th, at the Hotel Governor Clinton, 31st Street and Seventh Avenue, New York City. Fifty-five persons were in attendance. The chief topic for discussion was, "Statistical Methods in Advertising Research."

Malcolm Muir, President of the McGraw-Hill Publishing Company, acted as

Chairman. He stated that, in the existing stage of the depression, it has become necessary to scrutinize with unusual care all advertising appropriations. There is, however, a tendency to place advertising upon a basis more scientific than formerly was thought necessary.

The program was, in many respects, similar to that presented in Washington during the last Annual Meeting. It was felt, however, that since many New York members were not present at the Washington meeting, it was worth while to repeat, in essence, some of the papers previously given at the Annual Meeting. Students of the subject will do well to refer to pages 190 to 205 of the *Proceedings of the Ninety-Third Annual Meeting* (March, 1932, Supplement) for a summary of the material presented by Dr. Starch and Dr. Weld who were the first two speakers of the evening.

The third speaker of the evening was Dr. William J. Reilly, Marketing Consultant, who spoke on "The Law of Retail Gravitation." He began by stating that everyone realizes that the coming of the automobile and good roads has greatly extended the distance from which leading centers can draw trade. We have, however, heretofore lacked any mathematical measure of a city's drawing power.

Dr. Reilly presented a formula worked out by a study of actual data. He showed that a *city's drawing power for trade increases approximately in proportion to its population and varies inversely with the square of the distance from the city.* By aid of this mathematical law, it is possible to draw on a map the approximate borders between the districts contributory to given trade centers. The fact must be recognized, however, that dividing lines are not the same in the cases of all commodities. For example, the trading zone for higher priced articles is much broader than the trading zone for lower priced articles. This law of trade gravitation is also modified in many instances by the character of the roads, and by the existence of toll bridges and other obstacles.

In spite of these modifications and limitations, the law is, nevertheless, of great practical import. One important use is that it aids newspapers to know how far it is worth while to strive to extend circulation in order to aid their advertisers. Retailers can also see how far from their stores it is advantageous to spread advertising.

Mr. Oliver Everett, of the McCall Company, took the place of Mr. Lloyd Sweeting of the same concern in presenting a paper on the "Technique of Forecasting News Stand Sales of Magazines." He described the methods used by publishers in keeping track of the sales of various news stands. This is necessary in order that the publishers may send to each news stand the right number of magazines. If too few are sent, customers will not be supplied and circulation will shrink, while if too many are forwarded, the custom of making refunds to dealers will cause a heavy loss to the publishers.

The discussion was opened by Mr. W. B. Ricketts, Director of Research of Cowan & Dengler, Inc. He pointed out that the advertising statistician assumes that, under like conditions, the public will, at all times, respond in the same way to any given stimulus. In most cases, this assumption has proved valid.

He emphasized the fact that in the every-day research work of advertising agencies it is usually necessary, on account of cost and time factors, to obtain information that will indicate existing conditions with approximate correctness rather than data that more nearly approaches absolute accuracy. In many cases approximations that are correct within 5 or even 10 per cent meet the requirements satisfactorily.

In Mr. Ricketts' view, care in the framing of a questionnaire is extremely important, for the change of a word or two will modify, to a surprising extent, the results of the inquiry. In regard to sampling, he expressed the opinion that it is much more important to secure accurate items and a representative sample than to secure a large sample.

He concluded by stating that there was a great deal of interest at present in attempts that are being made to determine by test methods the relative effectiveness of different advertisements. A great deal of work has been done with the object of perfecting the technique of these testing methods and there are indications that real progress is being made.

The discussion was closed by Mr. Paul T. Cherington, Distribution Consultant. He enumerated seven different lines of advertising activity in which marked progress in statistical practice was being made. For example, he called attention to the fact that, owing to the work of the Audit Bureau of Circulation which has standardized and verified the records of the various periodicals, we now have much better statistics of newspaper and magazine circulation than were formerly available. Advertising men are now interesting themselves, not only in the quantity of the circulation, but also in its character.

The real problem before the advertising world today is to measure the value of the advertising itself, as distinct from the media employed. The chief obstacle in accomplishing this end is the difficulty of establishing good controls. Advertising sometimes produces unexpected results, for example, the advertising of an article by one store may cause the sales of the article to run up, not in the store that has advertised, but in nearby cut-rate stores.

The meeting adjourned.

WILLFORD I. KING

MISCELLANEOUS NOTES

Uptown New York Luncheon Meetings.—To date of this writing, there have been three meetings of the Uptown Luncheon Group of the American Statistical Association in New York City; all of these meetings have been held at the Fraternity Clubs Building. The object of these monthly meetings is to provide an opportunity for the New York members to hear an outstanding authority on some statistical or economic subject; discussion and comment form a very important part of the program after the speaker of the day has given his short remarks on the stated subject.

The first meeting of the Uptown Group was held on May 18. The speaker was Dr. Max Winkler, President of the American Council of Foreign Bond Holders, who spoke on the subject, "What Will Happen to War Debts and Reparations after July 1st?" Dr. Winkler outlined the circumstances which might be expected around the middle of the year, and said that the only real hope of this situation was the Lausanne Conference. If reparations were to be paid, Germany would undoubtedly be bankrupt and her creditors would not only lose the reparations payments but probably would also lose the private debts owed by her. Cancellation or extreme scaling-down of reparations and war debts was advocated in preference to default or bankruptcy.

The second luncheon meeting was held on June 15. Mr. Howard Scott, former technologist of Muscle Shoals, spoke on "The Imminence of Social Change." Mr. Scott pointed out that the price system and scientific production could not exist side by side, and predicted "technocracy" as the social system of the future. He stated that, in the near future, one-half of the population of this country could support the entire population due to technological advances; the problem is how to readjust this disproportionate allocation of income for the best social good. Among other things, abolition of the competitive system and the price system were suggested; the "income" of the population would be apportioned on the basis of the mechanical energy used.

So great was the interest shown in this meeting, that the Planning Committee decided to hold a second meeting on this subject and obtain a somewhat different point of view. Mr. David Cushman Coyle, a well-known engineer in New York City, therefore spoke before the third luncheon meeting on July 13. His subject was "The Irrepressible Conflict—Business vs. Finance." Mr. Coyle essentially agreed with Mr. Scott on his factual data and the serious problems which are presented due to technological and social advances. Instead of abolishing the price system, however, he would change our monetary habits from that of a debt economy to one of a spending economy. On the premise that one-half of the population can guide and do the productive work necessary for the entire population, Mr. Coyle pointed out that we would have to support the non-working half of the population by a taxation-dole system, or by a greatly reduced working day so that at least part of this unemployed half of the population could have a job, or by spending our money on non-productive enterprises.

There was no meeting in August because of vacations. It is planned to resume these luncheon meetings on September 14. They will be held each month on the Wednesday nearest the middle of the month, for the next year, under the direction of Mr. Stanley B. Hunt, Assistant Secretary of the Association, Tubize Chatillon Corporation, 2 Park Avenue, New York City.

Progress Report of the Committee on Governmental Labor Statistics.—Since the completion of its study on public employment office statistics the Committee has been giving some attention to promotion of the final recommendations of the report. One of the more important suggestions is that local employment offices should not compile statistical reports of their work but that the entire function of compilation and publication should be centralized in state headquarters or at Washington. The work of each local office in this field would be restricted to the maintenance of a daily record of transactions, a copy of which would be forwarded at the close of the day's business to the central statistical authority. The central office, by large-scale machine methods, would secure a degree of refinement in the analysis and presentation of the data, quite impossible for the local units of the service. It is also claimed for this suggested procedure that it would ensure absolute comparability as between the work of local offices and state systems and would yield an accurate national report on the work of the public employment offices of the country, in contrast with the present national totals compiled from the incomparable data of the various state services and federal offices.

In the Committee's own discussions and in its conferences with representatives of the International Association of Public Employment Services the objection was raised that the preparation of such a daily record of openings, applications, referrals and placements would impose too great a burden upon the local offices. The Employment Stabilization Research Institute of the University of Minnesota agreed to experiment with the procedure and for some time has been using in certain of the state employment offices the Committee's standard form for recording daily transactions. The Institute reports that, somewhat contrary to expectations, the record imposes little if any additional work upon the officials and that it seems entirely practicable. The Committee expects that the form will be tested also in the public employment office experiments at Rochester and Philadelphia and that arrangements may soon be made with a state statistical office to experiment with a centralized state compilation.

The Albany Chapter.—A dinner meeting was held on May 13, 1932, at 6.00 P. M. The gathering was addressed by Dr. Ralph G. Hurlin of the Russell Sage Foundation, who talked on "The Unemployment Survey in New Haven, Connecticut." A lively discussion followed. There were 24 persons attending the meeting.

Fifth Annual Meeting of the Boston Chapter.—The Fifth Annual Meeting of the Boston Chapter of the American Statistical Association was held in the auditorium of the Boston City Club on Thursday evening, May 12, 1932. Dinner was served at 7.00 P. M. There were 29 members and guests present at the dinner and business session, and 51 at the speaking session.

Business Session. The business session was called to order at 7.45 P. M. by the President, Mr. Leroy D. Peavey. The President spoke of the increasing interest in the meetings of the Chapter, and called attention to the advisability of holding joint meetings with other local organizations when this can be done to mutual advantage.

Officers elected for the ensuing year are:

President—Leroy D. Peavey, President Babson's Statistical Organization
Vice-President—Dr. John D. Black, Harvard University
Secretary-Treasurer—Roswell F. Phelps, Director of Statistics, Massachusetts Department of Labor and Industries
Counsellors—Edward A. Filene, William Filene's Sons Company; Professor J. F. Ebersole, Harvard Graduate School of Business Administration

The President appointed the following to serve as a Program Committee for the fall meeting:

Professor J. F. Ebersole, Chairman, Harvard Graduate School of Business Administration, Soldiers' Field, Boston, Massachusetts
Mr. K. B. Emerson, Business Research Department, United Shoe Machinery Corporation, 140 Federal Street, Boston, Massachusetts
Mr. E. L. Quirin, Babson's Statistical Organization, Wellesley Hills, Massachusetts

Speaking Session. The general topic for consideration at this meeting was "What Do Index Numbers Mean?" The speakers of the evening were Dr. A. G. Silverman, National Bureau of Economic Research, and Dr. Willford I. King, Secretary-Treasurer, American Statistical Association.

The following is an abstract of the address of Dr. Silverman:

What have all the measures grouped under the general heading of index numbers in common? Knowledge of the behavior of a group of elements is being sought. A certain economic realm, more or less clearly defined, is to be investigated, ordinarily to determine change over time. Further, a unit of commensuration is required. Finally, some form of combination of the elements in this economic realm, expressed in this common unit, is to be made. Here we have the more general problem of economic measurement. So-called index number problems occur even in the derivation of what commonly are assumed to be *individual* series or items—an assumption that may or may not be safely made.

By including many different conceptions and interests in economic measurement within a single term, "index numbers," purporting to embody a common technique, confused and low standards are perpetuated. The fact that an investigator may not be, and often cannot be, quite clear as to his intentions does not help matters. He may ask a specific question in the form of a verbalization of a numerical expression, but he does not thereby overcome his actual vagueness on the subject of what is to be measured, and why. Unfortunately, too, seemingly harmless mathematical expressions, especially if used in the measurement of movements over time, may sometimes imply more than is intended. And without some clarity regarding the economic realm to be measured, there is little chance of selecting the appropriate form of combination. In the present state of our knowledge of economic change and connection we often can do no more than search for common categories of change and sequence.

The unit of commensuration presents even more difficult problems. This is obvious for the combination of quantities, expressed in diverse physical units; it is less obvious for prices expressed in a common money unit. But prices, too, relate to diverse physical units and are likewise incommensurate. The difficulty is especially acute for stock price indexes.

When can sampling be logically employed in the construction of index numbers? When are we justified in calculating index numbers for relatively long periods of time? Are quantity, price, and other indexes similar in nature?

These questions overlap and to that extent their answers are inseparably tied together. In attempting to answer them it is useful to start with the conception of "common causation." This is a shorthand expression for signifying that a cause or set of causes operates uniformly on, or through, individual members of a class. One of the chief objectives in the construction of index numbers, at least when viewed historically, has been the measurement of the influence of "common causation." Measurement of monetary changes took the form of calculation of averages, on the consideration that, since individual price changes reflect the combined influence of particular factors peculiar to single or limited groups of prices and the common monetary factors, the average should reflect the net impress of the monetary factors alone.

In proving the existence and the extent of such "common causation" we may take the theoretical or the empirical route, or both, as in price measurement. It may be that a good deal of our work must look toward the development of technique designed to establish the existence and limits of the effects of common factors. We may not know what the economic realm delineated by "common causation" may be, except that it exists or is assumed to exist. If work must be with sample data, an average is justified only when there is evidence of the operation of common forces, if the average is to have the "reality" postulated. And then it is necessary to strike an average of a sufficiently large number of series to make possible the mutual cancellation of compensatory influences and thus to reveal the effects of the common factors operating on the system. The average in this case has some reality, or perhaps *a priori* validity, and is not merely a summarization characteristic.

The assumption of "common causation" may or may not be justified. Whenever it can be proved as invalid or is not substantiated, either on theoretical grounds or by a statistical examination of changes in the series to be combined, Dr. King should agree that the term index number is at least questionable on the basis of his definition of index numbers as samples. Then, it would follow that the term is improperly applied to practically all quantity indexes and to indexes calculated for relatively long periods; unless we are to select samples and strike averages on a frankly empirical basis.

Only the practically complete measurement of the economic realm, or the conception of "common causation," proceeding largely on *a priori* grounds, can give us a sound logical basis for the construction of index numbers. Thus I hold that sampling is relatively meaningless for quantity indexes over a broad economic realm, except perhaps for measuring short or long wave cycle movements. Similarity of movement in individual quantity series cannot be postulated with reference to secular movements, and we are far from possessing complete data. For very long periods of time sampling is inappropriate for price indexes. Though the monetary factors operate continuously, they do so on ever-changing members, which not only renders the members increasingly incommensurate, but precludes sampling. Even if we had an invariant unit referring to quantity of satisfaction, sampling would be logical only on the assumption of "common causation." For prices, this assumption might be, but for quantities it would not be, justified. Index number construction from samples has much greater validity for the measurement of cycle movements. Here, too, the difficulties of obtaining a unit of commensuration do not appear to weigh so heavily on the makers of index numbers. Often series are available for cyclical indexes, but not for long term measures, and the attempt to utilize the same series for both purposes may be self-defeating.

Group weights are justified only if it can be established that there is sufficient similarity of movement between the elements combined and the combination of the remaining part of the individual elements in the system. And here *a priori* or theoretical reasoning appears almost indispensable, for empirical testing is difficult and often impossible. Census categories used as a basis for applying group weights are totally uncritical, especially in the field of quantity indexes. The aggregation of individual quantity series and group indexes of such series often seems to proceed on the basis of what may be called the "accumulation of insufficiency," rather than on that of compensation of individual errors to reveal a common characteristic or to give a representation of a total.

Most makers of index numbers have in mind, although they may not explicitly state it, a distinction between representativeness and sampling. I believe that "representativeness" refers to a recognition that its determination, as compared with the kind of sampling that is based on a logical theory such as is discussed in this paper, is largely empirical. Often the assumed representative character of a series or group of series is a rationalization of what we don't know or are unwilling to admit. The appropriate comparison for determination of representativeness is between the items combined and the combination of those not to be included. To prove that the index numbers calculated move like another series of index numbers probably means that both have been constructed from much the same elements. Even if the part could be proved representative of the larger total, this would not necessarily mean that the part was a good index number, for both the part and the larger total may be bad for the same or similar reasons. The very idea of representativeness may be another way of pointing to the fact that the required homogeneity of composition, or common configuration, of the total and the index numbers referring to changes in the total are non-existent or confused, so far as our knowledge goes.

It is not here intended to insist that sampling and averages are always the central problems—or even always theoretically involved—in the combination of individual elements. In a sense, the use of group weights already contradicts the logic of sampling, and indicates that a total of contributing members is thought to be measured. There may be little or no similarity of movement among the different elements, and yet it may be desired to combine them. Combination may be intended as the empirical-statistical equivalent of a reduction in the number of equations of a formal mathematical system. Such reduction may be accomplished through summation (or aggregation) or by substitution and the use of equivalents. The technical procedure and criteria in *The Making of Index Numbers* are largely based on the logic of the equation of exchange, represented in Professor Fisher's *Purchasing Power of Money* as indispensable to the solution of the Walrasian system of equations defining an economic equilibrium. One may for certain purposes postulate the economic significance of given categories and assume their qualitative continuity, and then calculate, say, quantity indexes for these categories, to be representative of whatever economic connections can be established between the movements of the index numbers and of other elements in the economic system, no more nor less. For example, I have calculated index numbers of British export and import quantities from 1880 to 1913 for restricted classifications given by official sources in order to reduce the numbers of time series to be analyzed. Such index numbers mean much more for study of cyclical fluctuations than for secular trend. Also, the greater the degree of combination the less is the possibility of establishing meaningful relations.

Summation is not always undertaken to compensate errors, but may be for the purpose of covering a larger field. Measurement of changes in welfare for the total economy, or for given parts of it, may be the objective, with a view to evaluating consequences of economic evolution or perhaps in the interest of redefining social objectives. Social budgeting or accounting is made inevitable by limited resources and by the limited possibility of satisfaction of human wants. Quantity indexes generally relate to aggregates. Conceptually they are not averages, even though averages may be used in the technical procedure of obtaining them. What quantity indexes report is the changing number of composite standard units. Price indexes, too, may be viewed as rates with reference to a composite standard, a dollar's worth or a basket in a given year; and from this standpoint they may also be considered as aggregates.

The difficulties presented by a lack of a homogeneous unit of commensuration in economics, and the question whether price and quantity indexes are correlative in respect of permitting meaningful combination (for purposes of obtaining some value index) and in respect of formulae employed in their construction, were briefly referred to.

The second speaker of the evening was Dr. Willford I. King, Secretary of the American Statistical Association. He began by taking issue with the old idea that index numbers represent merely, in some vague sort of way, the general movements of the data in the totality. He pointed out that the same totality of data may be used to answer many diverse questions and that the exact answer to each question may be represented by a different set of relatives derived from the data.

The speaker emphasized the fact that series of ratios derived from sample data may be very different from those derived from complete data. Since these two concepts are different it is well to give them two different names, the term "index numbers" being reserved for the indicators derived from the sample data. These indicators, or index numbers, can never be expected to answer with precision the question answered by the relatives representing the totality. However, with reasonably adequate sampling, the course of the index number may approach rather closely to the course of the relatives just mentioned. In such case, the index number is satisfactory.

He agreed with Dr. Silverman that the use of sampling is not legitimate unless most of the items in the totality are dominated by a common cause. He held, however, that such domination by a common cause is not restricted to price data—for example, the yields of grain on the different farms of the United States are affected by developments in methods of cultivation, by the weather prevailing, and by the variety of seed used. It is then perfectly feasible to secure reasonably accurate estimates of grain yield in the country as a whole by securing reports from well selected sample farms.

To be useful, the sample must, of course, be representative. It may be safely assumed that pot roast is representative of beef in general and will be influenced by the various forces affecting beef. One cannot be so sure, however, that sugar is representative of foods in general.

Quantity indexes are neither more nor less reliable than price indexes. To compute quantity indexes, it is necessary to use arbitrarily defined units as, for example, dollar's worths in a base year. Experience indicates, however, that, when the number of items entering into the index number is rather large, the results are not materially affected by the arbitrary nature of the unit, for, in most cases, a change in the definition of the unit does not affect markedly the course of the index number. The price index is subject to all the weaknesses inherent in the quantity index for, before prices can be averaged, one must be sure that the prices apply to definite quantities, hence the arbitrary characteristic of the quantity unit enters also into the price index.

In all statistical studies, it is essential that the question asked be made very specific and that all units used be defined with precision. This general rule applies, of course, to index numbers but is no more applicable to them than to other types of data.

While index numbers are not instruments of precision, they do, nevertheless, in hundreds of cases, yield results which are close enough to the truth to answer all practical purposes. The use of index numbers is therefore extremely helpful to the general public as well as to the scientist.

Following the addresses, there was spirited discussion from the floor.

ROSWELL F. PHELPS, *District Secretary*

The Chicago Chapter.—The final dinner meeting of the Chicago Chapter for the 1931–1932 season was held on Tuesday, April 19, with 58 in attendance. At this meeting the annual reports of committees were heard and the election of officers and directors for the season took place. Professor Henry Schultz of the University of Chicago was elected President, Mr. John L. Sweet of the Federal Reserve Bank, Vice-President, and Mrs. Bernice Lamb of the Federal Reserve Bank was reëlected Secretary-Treasurer. Directors for the coming year are Professor C. A. R. Wardwell of Northwestern University, Miss Marion Mead of the Illinois Chamber of Commerce, and Mr. H. L. Jones of the Illinois Bell Telephone Company.

The general topic for this last meeting was "Shall We Legislate a Higher Price Level?" The subject was ably discussed by Mr. Henry A. Wallace, Editor, *Wallace's Farmer*, and Mr. George A. Putnam, Economist, Swift and Company. Mr. Wallace is one of the leading agricultural economists of the country and has been actively engaged in obtaining Congressional action to stabilize prices at a higher level. His discussion followed these lines, while Mr. Putnam, who is a money and banking expert, focused his talk on the relationship of the price level to the gold standard.

Activities of the Cleveland Chapter.—The Business Statistics Section of the Cleveland Chapter had its final meeting for the season in April. Nine meetings were held during the season with an average attendance of 23 members and guests.

The annual banquet of the Cleveland Chapter was held on April 8 at the Chamber of Commerce Club. The attendance was in excess of 150. The meeting was held in coöperation with the Ohio Group of Statisticians.

We were particularly fortunate in securing as speakers, Professor Irving Fisher, Mr. John Scoville and Colonel Leonard P. Ayres.

Professor Fisher addressed us on "Some First Principles of Booms and Depressions."

Mr. John Scoville, Statistician for the Chrysler Corporation, chose as his subject, "The Behavior of the Automobile Industry in Depression."

Colonel Ayres, Vice-President of the Cleveland Trust Company, described some "New Source Material for Business Cycle Research."

Officers for the 1932–1933 year are as follows: President—Howard W. Green, Cleveland Health Council; Vice-President—D. A. Hill, The Ohio Public Service Corporation; Secretary—E. A. Stephen, The Ohio Bell Telephone Company.

The Connecticut Group.—A local chapter of the Association is being organized in Connecticut. Chester H. Wheldon, Jr., of Yale has been appointed District Secretary. Meetings will start early in the fall and will probably be held in rotation in Bridgeport, New Haven, Hartford, and New London.

The Philadelphia Group.—The Philadelphia Statistics Group held its third and final meeting of the academic year on May 6. The topic, "The Present Depression and Steps Toward Better Planning of Production," was discussed, with Dr. Leo Wolman of Columbia University and the Amalgamated Clothing Workers of America speaking on "Some Aspects and Consequences of the Present Depression," and Dr. Joseph H. Willits, Director of the Industrial Research Department, University of Pennsylvania, speaking on "Steps Toward Better Planning of Production."

Meetings of the Pittsburgh Chapter.—At the Chapter Meeting on April 20, Dr. Francis Tyson read a very well-prepared paper on "Price and Cost Factors in Business Recovery." Mr. J. E. Webster of the Westinghouse Electric and Manufacturing Company gave a short discussion on "Mass Production as a Basis of Prosperity," while Professor McCabe of the University of Pittsburgh commented on Dr. Tyson's paper. Approximately thirty attended the meeting, which developed into an unusually stimulating discussion.

The May meeting, which was held on the 26th, was very interesting and attended by approximately thirty members. Dr. Watkins gave a fine presentation on "This Depression and the Next."

At the June 23rd meeting, discussion was led by Dr. Montfort Jones and Dr. George McCabe, of the University of Pittsburgh, on the subject of "The Probable Effect of the Federal Board's Policy in Purchasing Government Securities." Approximately thirty-five attended the meeting, with Mr. Nevin, local head of the Federal Reserve Bank, presiding.

On July 28 the Chapter reviewed Colonel Rorty's recent paper in the *Harvard Business Review* on "How May Business Revival Be Forced." Mr. Bervard Nichols of the Bureau of Business Research led the discussion. Mr. Nevin again presided.

Mr. T. H. Gerkin, Resident Editor of *Iron Age*, has been elected Assistant Secretary of the Chapter.

The San Francisco Chapter.—Four meetings were held by the San Francisco Chapter during the past fiscal year, with average attendance of 35 at each meeting.

The election of officers and general business meeting of the year was held on Friday, October 30, 1931, at the Bellevue Hotel. Dr. Henry F. Grady, Dean of the College of Commerce, University of California, and Trade Adviser to the San Francisco Chamber of Commerce, spoke on Dislocation of World Economics.

Dr. Grady developed the view that the present acute disturbance of world economic equilibrium is due primarily to the War, the revolutionary development of machine technique, and the disintegration of political organization. The War accentuated nationalism in a world economically international. Instruments of economic armament have been multiplied, and have taken the form of embargo tariffs and export bounties, and have caused congestion in commodity and gold flow with the resulting serious world trade dislocation and distress.

The second dinner meeting of the year took place December 11, 1931, with Dr. Norman J. Silberling of the Silberling Research Corporation as the principal speaker. The topic discussed was the Business Outlook for 1932.

Dr. Silberling reviewed some of the major causes of the present depression, but could offer little if any encouragement for improvement during 1932. He regarded the present situation as an aftermath of the War and stated that this might be regarded as the second installment of the costs of the War. The condition of various industries and the financial situation were examined at length.

The meeting of February 4, 1932, was a discussion of the Silver Problem from the Chinese Point of View by Theodore J. Kreps, Associate Professor of Business Administration at Stanford University.

Dr. Kreps had just returned from several months' travel in the silver-using countries and had made a first-hand study of the effects of falling silver prices. He summarized the effects of the decline in the price of silver on Chinese trade, general prices and wages. He pointed out the stimulation of Chinese industry which had resulted from the mild inflation, and spoke of the attitude of Chinese business men toward the problem.

The topic for the meeting of May 12, 1932, was A Critical Appraisal of Indexes of General Business Activity, discussed by Maurice I. Gershenson of the Silberling Research Corporation and Robert W. Bachelor of the Federal Reserve Bank of San Francisco.

The speakers stated that the continued drop in business activity during the past three years had shown a need for a critical examination of indexes which attempt to measure changes in business from month to month. Fundamental assumptions involved in indexes of business were examined from the standpoint of methods of construction such as computation of trend, isolation of seasonal movements, smoothing of data, combining series with varying magnitudes of fluctuation, weighting of each group entering into the composite, representativeness of the data used as a sample of all economic activities, and handling of habitual leads and lags of some series compared with others. Typical methods of constructing currently used and supposedly representative measures of business activity were then examined in view of the principles developed. These indexes were then classified as to their actual significance and reliability.

United States Bureau of Labor Statistics.—The Bureau's studies of wages and hours of labor in air transportation, the hosiery and underwear industry, the boot and shoe industry, the manufacture of woolen goods, and the dyeing and finishing of textiles have been completed and summaries of the data obtained are being prepared for publication. Reports on wages and hours in cotton-goods manufacturing, automobile repair shops, gasoline filling stations, the slaughtering and meat-packing industry, and metalliferous mining have been carried in recent issues of the *Labor Review*. Field work on the surveys of wages and hours in the lumber and tanning industries has been completed, and the gathering of data for the clothing and the motor-vehicle industries is under way.

The investigations of the effects upon employment of technological changes in the electric light and power and the automobile-tire industries have been finished and the information obtained is being prepared for publication. A similar investigation is now in progress for mail transportation.

A bulletin giving the text of Federal and state legislation relating to public and private employment offices is being prepared.

The annual review of industrial disputes in the United States, covering 1931, was published in the *Labor Review* for June, 1932, comparative figures also being given for each year back to 1916.

A study made by the Bureau of operations during 1931 under state old-age pension laws was published in the June, 1932, *Labor Review*.

Another article of special interest, published in the July *Review*, gave the provisions of Federal and state anti-injunction laws in labor disputes.

The series of articles on wages in foreign countries, based on reports furnished by representatives of the Department of State, is being continued in the *Labor Review*.

Publications of the Women's Bureau.—Preliminary reports on two studies have recently been published by the Women's Bureau of the United States Department of Labor. The first deals with the economic status of women engaged in the manufacturing of wearing apparel in Connecticut in the fall of 1931. The pay-roll data for hours and wages that formed the basis for the Bureau's report were obtained from 106 firms employing 10,009 workers—94 per cent of the state's wage-earners in the clothing industry, according to the 1930 Census of Occupations. With the exception of the hat factories, these were chiefly woman-employing plants, more than three-fourths of the wage-earners being women. Pay-roll records were taken for the week recommended by the firms as most nearly normal or as full-time as any.

In addition, a preliminary report on a state-wide survey of North Dakota has been published. The report covers 204 establishments located in 21 cities and towns and employing 1,742 women. The largest group of establishments included were hotels and restaurants, which made up more than two-fifths of the work places visited and employed nearly a third of the women. Stores, telephone exchanges, laundries, manufacturing establishments, and beauty shops were other industries covered by the survey. The preliminary report is confined to wages and hours of one pay-roll period of the women employed. The complete report will include year's earnings, working conditions, and facts as to age, marital condition, and length of service.

Recent Publication of the Bureau of Agricultural Economics.—*Factors Affecting the Price of Rice*, published under date of April, 1932, as U. S. Department of Agriculture Technical Bulletin No. 207, is another bulletin in the series of price analysis publications relating to individual farm commodities. Previous bulletins in the series have dealt with oats, hogs, and cotton.

The Canadian Census of Merchandising and Service Establishments, 1931.—The first reports for the Canadian Census of Merchandising and Service Establishments have been released and the preliminary tabulation is proceeding rapidly for the larger cities. The progress so far reported compares favorably with the results secured for the United States Census of Distribution which commenced a year earlier than the Canadian survey. The Canadian Census was based on names and addresses of establishments secured by regular census enumerators. Schedule information was secured almost entirely through the mails, although field workers were engaged to secure reports from delinquent establishments. It is expected that the Census, when completed, will furnish a comprehensive picture of merchandising in Canada. The system of classification in the Canadian Census has closely followed that of the United States Census of Distribution, by which procedure it is hoped that comparisons between the two countries will be facilitated.

Business Research Council.—The Business Research Council has recently published a report under the title *Economic and Business Research in American Colleges and Universities*, which presents the results of a census of research projects taken during the spring and summer of 1931. Donald R. Belcher, a member of the Business Research Council through appointment by the American Statistical Association, is Chairman of the special committee responsible for this publication.

The report covers research projects completed during the academic year 1929–1930 and projects in progress during the year 1930–1931. In all, 620 projects are listed, classified according to subject and cross-indexed for ease of reference. In addition to the title of each project, a brief description of the nature and scope of the research is given, together with information concerning status of the work, availability of results, and medium of publication where results have been published. Both investigations undertaken by organized research or other bureaus and those made by individuals associated with the institutions are included.

The report also lists some 80 recurring series of data compiled by the institutions, giving in each case the frequency of compilation, availability, and medium and frequency of publication, where data are published.

Ninety-two separate institutions reporting research in business and economics are included. In many instances reports were received from several schools or departments of a given institution, so that the number of essentially independent organizations for which data are given is 108. A list of these institutions, together with titles and chief fields of interest of organized research bureaus and details concerning their periodic publications, are shown.

Copies may be ordered by writing to the Business Research Council, 20 Vesey Street, New York City.

Activities of the National Distribution Council.—The National Distribution Council of Washington, D. C., an organization of research men interested in marketing problems, has just completed its second year of existence. A series of seven dinner meetings and six luncheon meetings was held during the past year. The attendance was exceptionally good and much interest was shown in the various papers presented. In each paper an attempt was made to present material which would contribute to the knowledge of the subject. The following program gives an idea of the scope of the work of this organization and the character of its membership.

During the first year all dinner meetings were held at the Cosmos Club and the luncheon meetings at the University Club. During the year just past, all meetings were held in the new building of the Brookings Institution.

DINNER MEETINGS—*1931–1932*

October—New Methods of Allocating Costs of Distribution, by Wroe Alderson, Department of Commerce.

November—The Relation of Stocks of Commodities to the Business Depression, by Dr. Fred W. Dewhurst, Department of Commerce.

January—Distribution and Consumption of Coal, by Dr. Harvey Young, Bureau of Mines.

February—Trade Statistics and Price Stabilization, by Dr. W. H. S. Stevens, Economist, Washington, D. C.

March—An Analysis of the Problems Connected with the Marketing of Radios and Radio Equipment, by Dr. N. H. Engle, Expert in Marketing, Bureau of the Census.

April—Agricultural Taxation and Some Relations to the Crop Surplus Problem, by Dr. Eric Englund, Department of Agriculture.

May—The Economic Meaning of Hand-to-Mouth Buying, by Dr. L. S. Lyon, Brookings Institution.

LUNCHEON MEETINGS

November—The Marketing Activities of the Bureau of Foreign and Domestic Commerce, by Dr. Frank Surface, Department of Commerce.

December—The Marketing and Other Activities of the Brookings Institution, by Dr. L. S. Lyon, Brookings Institution.

February—Marketing Activities of the Bureau of Agricultural Economics, by Dr. E. J. Working, Department of Agriculture.

March—An Analysis of Drug Store Transactions, by Mr. B. B. Aiken, Department of Commerce.

April—Marketing Activities of the Federal Trade Commission, by Mr. Martin Behrens.

May—Annual Business Meeting.

The Joint Meeting of "Section K" and the Econometrical Society.—The attention of our readers is called to the highly profitable and interesting meeting of Section K (economic and social sciences and statistics) of the American Association for the Advancement of Science at Syracuse, June 20–23, jointly with the Econometric Society. In attendance, quality of papers and discussion, and general interest, this was far ahead of the previous meetings of the two organizations. A complete report appeared in *Science* for July 22.

The Brookings Institution.—There have been the following changes in the personnel of the Brookings Institution:

Dr. Leverett S. Lyon has been made Executive Vice-President.

Mr. William F. Willoughby has retired as Director of the Institute for Government Research, and is succeeded by Dr. Arnold B. Hall, recently President of the University of Oregon. Mr. Gustavus A. Weber has retired, and Mr. Herbert Wilson has accepted a position with the United States Bureau of the Budget.

In the Institute of Economics, Dr. Robert R. Kuczynski, Mr. Max Sasuly, and Miss Adelaide R. Hasse have resigned.

The following appointments have been made to the staff of the Institute of Economics: Dr. Maurice Leven, formerly with the Committee on the Cost of Medical Care; Dr. Clark Warburton, formerly with the research staff of the Federal Reserve

Board; Dr. Horace B. Drury, formerly economist with the United States Shipping Board; Professor Chester B. Pond of Lebanon Valley College; Mr. V. S. Kolesnikoff, formerly with the National Bureau of Economic Research; and Mrs. Umber Arthun Warburton of Atlanta University.

The following persons have been awarded research Fellowships for the academic year 1932–33: Aaron V. Abramson, Milner Fellow, Brown University; Robert H. Connery, Graduate student, Columbia University; Howard A. Mackenzie, Teaching Fellow, University of California; Valentine S. Malitsky, Graduate student, University of Minnesota; Harold W. Metz, Graduate student, Yale University; Lionel V. Murphy, Instructor, University of Oklahoma; Stanley I. Posner, Research Assistant, University of Chicago; Irma M. Rittenhouse, Assistant Editor, Encyclopaedia of the Social Sciences; Boris B. Shishkin, Graduate student, Columbia University; Ernst W. Swanson, Research Fellow, University of Chicago; Cecil H. Tolbert, Cowles Fellow, Yale University.

Consulting Fellowships have been awarded to Thomas S. Barclay, Associate Professor, Stanford University, and to Abraham D. H. Kaplan, Professor, and Director of Social Studies, Bureau of Business and Social Research, University of Denver.

PERSONAL NOTE

Mr. R. E. Watts, for many years Head of the Judicial Statistics Branch of the Dominion Bureau of Statistics, Canada, has recently been superannuated. Mr. Watts contributed an article on "The Influence of Population Density on Crime" to the March, 1931, number of this JOURNAL.

MEMBERS ADDED SINCE JUNE, 1932

Arnold, Arthur Z., Research and Teaching, City College, New York, N. Y.

Andersen, Kenneth B., Secretary, American Management Association, 20 Vesey Street, New York, N. Y.

Becker, Thomas H., Graduate Student, University of Michigan, Ann Arbor, Mich.

Breitenstein, August J., Engineering Department, Philadelphia and Reading Coal and Iron Company, Ashland, Pa.

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Conrad, Dr. Herbert S., Research Associate, Institute of Child Welfare, University of California, Berkeley, Cal.

Crandall, R. L., President, Crandall, Pierce and Company, Publishers of the *Business Index*, 1138 First National Bank Building, Chicago, Ill.

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Ensign, Inez S., Student, 320 Park Avenue, East Orange, N. J.

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Field, Professor Kenneth, School of Business Administration, University of Colorado, Boulder, Colo.

Finnegan, Joseph H., Student, New York University, Washington Square, New York, N. Y.

Greene, A. B., Engineer, Railroad Commission, Tallahassee, Fla.

Hale, Roger F., Bureau of Agricultural Economics, Washington, D. C.

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Imai, Dr. Takeo, Biological Institute, Tohoku Imperial University, Sendai, Japan.

Kinsella, Nina, Department of Justice, Bureau of Prisons, Washington, D. C.

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Leland, Professor Thomas W., Department of Accounting and Statistics, A. & M. College, College Station, Tex.

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Raenkham, Thawee, Section of Vital Statistics, Department of Public Health, Bangkok, Siam.

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Schavel, John, Jr., Brooklyn Borough Gas Company, Mermaid Avenue and West 17 Street, Coney Island, N. Y.

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Stover, Albert A., Jr., Brooklyn Trust Company, 177 Montague Street, Brooklyn, N. Y.

Sweet, John L., Federal Reserve Bank of Chicago, 164 West Jackson Boulevard, Chicago, Ill.

Taeuber, Dr. Conrad, Mount Holyoke College, South Hadley, Mass.

Thompson, Dr. Tracy E., Bureau of the Census, Washington, D. C.

Waters, James J., United States Bureau of Investigation, Washington, D. C.

Willits, Dr. Joseph H., Wharton School, University of Pennsylvania, Philadelphia, Pa.

Wilson, Alfred J. P., Research Engineer, 538 East 21 Street, Brooklyn, N. Y.

Wilson, Winfred P., Accounting Department, Statistician's Section, Michigan Bell Telephone Company, Detroit, Mich.

REVIEWS

Economic Stabilization in an Unbalanced World, by A. H. Hansen. New York: Harcourt, Brace and Company. 1932. ix, 384 pp.

Professor Hansen covers almost every conceivable subject in this lengthy and very useful volume. Russian dumping, reparations, the Bank for International Settlements, wage policies, unemployment insurance, and the optimum theory of population are a fair sample of the diversity of subjects treated; but the author is not always successful in knitting the story together. Although the volume represents a large amount of industry and much careful thought, any writer, courageous enough to embark on so ambitious a program without devoting a generation to its consummation, exposes himself to endless criticism. In what follows, several important questions are raised concerning Professor Hansen's treatment. Space does not permit a discussion of numerous points of agreement.

Reparations are held to be the decisive factor in the determination of Germany's economic future. It is contended that Germany is deprived of one dollar of capital for each dollar collected from the taxpayer for reparations, and that the consumption standards of Germany have not been reduced as a result of reparation payments. In view of Germany's tax system, which is characterized by large consumption taxes, it is especially difficult to understand why a *large* part of the taxes collected for the payment of reparations does not reduce consumption rather than savings. Moreover, no evidence other than reference to well-informed opinion is offered that consumption standards have not suffered. One may conceivably argue that the necessity of paying reparations explains the large influx of foreign capital, and, therefore, that the reduction in consumption standards suffered as a result of the payment of taxes for reparations, is to be offset by the gain in purchasing power to be associated with the influx of capital. It may also be contended that the payment of reparations induced conditions favorable to an increase in the export trade, and, therefore, that employment was increased, and the loss of goods involved in the payment of reparations is to be associated with an increase in output and employment rather than a reduction in consumption. But even if this position were taken, it might still be maintained that the standard of living was reduced as a result of the payment of reparations. In other words, those who are taxed for the purpose of paying reparations, even if employment and purchasing power are increased as a result of the payment of reparations, would consider that their standard of living had been impaired.

One more point on reparations. Hansen admits that reparation payments have tended to depress prices in Germany, but then he goes on to say that *until 1929–1930* the pressure tending to depress German prices was offset by the upward tendencies resulting from the inflow of capital. But the developments of the last two years are not easily explained in that manner. Germany's losses of gold and foreign assets have been much beyond the most optimistic anticipation of those who view the loss of gold by Germany and an influx into the United

States and other countries as the process by which reparation payments are induced. In spite of the fact that Germany has exported virtually all of its gold and sold most of its foreign assets and the German Government has taken drastic measures to reduce prices and wages, the decline in prices in Germany has not been more precipitate than in the United States.

Much has been said in recent years concerning the problem of capital equities, fixed costs, and the like, especially in relation to the problem of international competition. On this question, Hansen expresses himself in no uncertain terms and, in the writer's opinion, assumes a position that is clearly fallacious. He contends that cost accounting is not concerned with gifts and windfalls, and that the German industrialist cannot produce more cheaply because he has been freed of the necessity of paying interest on bonds as a result of the inflationary episode. But this is just exactly what German firms can do. In so far as they are relieved of fixed charges, they can sell abroad more cheaply than they otherwise would. Hansen contends that the reduced equity of bondholders is to be offset by an increased equity of stockholders. But stockholders do not have to be paid as a condition to staying in business; bondholders, on the other hand, are paid unless the directors are content to appeal to the bankruptcy courts. On the other hand, there is some truth in Hansen's position although he does not make this point (which follows); and English authorities, in particular, neglect it: A default on bond interest, whether it is the result of inflation or reorganization, raises costs of industry later, for the borrowers (in Germany, say) are forced to pay a higher price for capital later. Therefore, it may be held that the gain to be associated with payments on capital already obtained, is to be offset by losses to be associated with the increased cost of obtaining capital in the future.

Hansen discusses the problem of prices at many points. In his opinion, declining prices, even if associated with improved technological conditions and increased productivity per capita, have unfortunate results. A reduction of costs and prices may result in the expenditure of an increased amount of money for the products of industries profiting from a reduction of costs, and for that reason, he argues that other industries, unable to bring down costs, would be affected adversely, for a smaller amount of money would be expended for the products of the latter. But why assume an elasticity of demand for the favored industries that would require the expenditure of additional sums of money for their products? And, moreover (it may be added) it is conceivable that, if prices were stable, the favored industries might attract an amount of purchasing power so large that the other industries would suffer. Hansen also argues that industries profiting from important improvements always seem to be in a depressed state because all firms are not in a position to adopt such improvements. The wheat industry, which he uses for illustrative purposes, is an unfortunate one. Other considerations explain its depressed state more adequately. And what of the automobile industry from 1910 to 1929?

In disposing of the high wage theory of prosperity, Hansen goes too far. His position is that increased purchases can only result from an increase in the supplies of money and credit, which are determined by other considerations and forces.

Why can it not be assumed that a *general* policy of high wages—supported by the government, labor unions, and employers—would induce the necessary creation of currency (a purely automatic matter today) and later the necessary supplies of credit. The elasticity in our banking systems is greater than Hansen assumes, and, moreover, we are not bound to the gold standard. This much may be conceded. An increase in wages, generally enforced, would result in the creation of additional purchasing power and would bring higher prices; but the increase in prices would not be adequate to offset the increased costs involved in the payment of higher wages, for wages constitute but one element in costs, and other income recipients would be affected adversely.

Although unemployment insurance reduces the mobility of the worker, it also drives out of business the inefficient users of capital. Hansen offers no proof or elaboration of this position. Undoubtedly the costs of industry are thus increased; but the problem is not as simple as Hansen assumes. Industries that cannot pass the additional costs on to the consumers—it is assumed by the reviewer that at least part of the costs are passed on to the consumer—will suffer as well as industries in which labor costs constitute a large part of all costs. It does not necessarily follow, as between firms in the same business, that the less efficient firms will be affected adversely to a greater degree than others. If individual firms produce at varying costs, and the industry under consideration as a whole sells less, it may well be that all firms may cut down production to some extent. In so far as the additional burden is not passed on to the consumer, other recipients of income suffer. In other words, in so far as the wage-earner does not pay as a consumer, what he gains as a wage-earner, other classes lose as consumers or producers. There may also be some long-run effects on the accumulation of capital; and the problem of the general price level ought to be considered.

There are numerous statements to which exception must be made, but to which only passing reference can be made here. Industry alone can solve the problem of lower costs; neither central banks nor governments can cope with the problem. (What of inflation?) Elsewhere, Hansen says that the abandonment of the gold standard has been the chief cause of the absorption of gold by the United States prior to 1925. True enough, the United States could not have absorbed so much gold if other countries had not abandoned the gold standard; but the abandonment of the gold standard as well as the gold flows were the result of the chaotic economic conditions in Europe. A few other statements need only be made to be refuted. Thus, the creditor classes in France lost 80 per cent of their property. (Are people either creditors or debtors exclusively?) The industrialists were the real power behind the throne both in Germany and France; in the latter country they rid themselves of 80 per cent of their indebtedness. (The war and post-war conditions which required the application of inflation, in particular the requirements of war finance, are thus neglected.)

In spite of the numerous criticisms suggested, the book is useful and provocative and on the whole it constitutes a sound treatise on a subject that is encyclopedic in its ramifications. College students and intelligent citizens will be thankful to Professor Hansen for having undertaken a task which can never be adequately appreciated by professional economists. He has read widely and considered thoughtfully many of the problems that vex the world today.

S. E. Harris

Harvard University

Factors Affecting the Prices of Livestock in Great Britain, A Preliminary Study, by K. A. H. Murray. University of Oxford Agricultural Economics Research Institute. 1931. 180 pp.

This comprehensive study of the prices of livestock in Great Britain was developed by Mr. Murray largely while a student in the United States. Its philosophy and technical methods, therefore, reflect the work of Drs. Warren and Pearson, under whom he studied, more than they do those of English or Continental economists or statisticians.

In spite of its modest title, "A Preliminary Study," the book presents a broad study of cattle, hogs, and sheep, reviewing for each group of products in turn the development of the industry, the relative significance of domestic production and imports, and changes in these relations over a half-century. The analysis of prices is considered only after establishing this broad descriptive foundation for the analytical material to be presented.

The differences in the price movements for different qualities of products are carefully developed. In the case of beef, the relative premium on prime beef is found to be positively related to changes in the general level of prosperity, as shown by wages and the price of consols. The premium on first quality mutton and lamb, however, showed an opposite tendency; the price of the better grade rising less rapidly in times of rising price levels, and falling less rapidly in periods of declining prices, than the price for lower quality mutton and lamb.

The effect of prices upon supply is likewise investigated. With sheep, British marketings responded to prices with an irregular lag of three to four years; while changes in hog marketings reflected price changes one to three years earlier. No evidence of regular cyclical change was found in British beef production, however, the numbers of "store cattle" (feeders) imported from Ireland being currently adjusted to agree with feed supplies available.

Although the preliminary investigation went into the seasonal variations in supplies and in prices, and into shifts in these over the period, the final statistical analysis of factors affecting prices was restricted to annual data, and the methods used were relatively simple. Both pre-war and post-war years were considered, and many of the series ran back to 1800 or earlier. The following conclusions, substantiated by multiple correlations of between 0.80 and 0.90 in most cases, are of interest.

1. The (deflated) price of beef in England varies markedly with the (deflated) level of wages, and also to a less extent with the supply of beef imported.

2. The relation between beef prices and imports shifted from a positive relation, about 1875, to a negative relation, about 1900. The author interprets this as indicating that whereas earlier high prices tended to attract large imports, more recently large imports tended to depress prices. This changing relation

provided an interesting occasion for the use of Tschetverikoff's "sliding coefficient of correlation."

3. In sheep and mutton, the level of wages was found similarly important, with the number of sheep in Great Britain, or the receipts on British markets, as the second factor in importance.

4. In the case of pigs and hog products, wage levels apparently had a negligible importance, since hog numbers in Great Britain and volume of imports alone served to explain two-thirds to three-quarters of the price variance. The prices of imported products, such as bacon and hams, were more closely related to volume of import than to any other one factor, with numbers of pigs in Great Britain as a distant second.

These conclusions throw much light on the broad behavior of live-stock prices in Great Britain, even though they are based on relatively simple studies. The economist will find the theoretical framework for the effect of supply on price and of price on supply simply and adequately treated. Necessary refinements and amplifications of the simple theory are recognized at several points, but are not developed further.

During the past two decades there has been a rapid evolution in technique of price analysis and in the basis of economic theory which underlies it. The great bulk of this work has been done on this side of the Atlantic. One may wonder how much the English reader will learn of this development from the brief historical review in Murray's book (page 66):

> Measurements of the effect of the supply of a commodity on the price have been attempted for many years, one of the first being the attempt of Gregory King, in the seventeenth century, to estimate the effect of the production of wheat on the price. In 1928 Warren and Pearson published their work on Inter-relationships of Supply and Price, dealing with production and prices, both farm and retail, in the United States.

No references to other price-analysis studies are given!

The book as a whole is an excellent and comprehensive study, well written and carefully prepared and printed. It puts on record many new facts on price relations, and adds a sizable volume of new data to that already available to the student. One can only wonder, however, what the writer might have accomplished if his attention had been called to some of the more baffling details, and some of the more intricate economic problems, that lie covered up by the simple annual averages and broad relations with which he deals.

MORDECAI EZEKIEL

Federal Farm Board

The Balance of Births and Deaths, Vol. II, Eastern and Southern Europe, by Robert R. Kuczynski. Washington, D. C.: The Brookings Institution. 1931. 170 pp.

Although officially designated the second, this volume is really the fourth in the Brookings Institution series on the vital statistics of different countries. The first volume dealt with the balance of births and deaths in western Europe. Separate volumes have been published on Fertility and Reproduction, Methods of Measuring the Balance of Births and Deaths, and on Birth Registration and Birth Statistics in Canada. Thus with the discussion of methodological problems out of the way and with the facts of western Europe available for comparative purposes, the author comes to the interesting task of measuring reproduction in these parts of the world, the conditions of which have at times so greatly agitated the immigration restrictionists of the United States and other countries.

Eastern and southern Europe includes not only Russia, Poland, the Balkan countries, and the European nations on the Mediterranean but also the central European states of Austria, Hungary and Czechoslovakia. Data for some of these countries, especially the Mohammedan, are so defective that even the birth rate cannot be calculated. On the other hand, for some of the other countries there are reliable statistical materials not only for the country as a whole but also for many provinces and cities, sometimes extending over considerable periods of time. The data of major importance cover the span of years from 1896 to 1929.

The author has used both the published and the unpublished figures of the central statistical offices and the institutes of demography of the countries concerned.

The treatment of the subject is wholly factual in the sense that no surmises or "possible explanations" of the phenomena are offered and no unqualified predictions have been made. Such estimates as are made are wholly in the interest of a more accurate view of what is, not what may be. The study "makes no attempt to analyze the social causes or possible economic and political consequences of the trend of population growth or decline in the countries with which it deals."

The first third of the book sets forth, country by country, the data by which its population growth has been measured. The second third is given over to an appendix containing a description of the system, or lack of it, which prevails in each country for the registration of births. The last third of the book gives the sources used in the preparation of the body of the report, with additional tables on birth rates (some as far back as 1810) in the various countries, total population and births, women of child-bearing age, age of mothers, life tables for females and fertility tables for different countries during the last three or four decades.

The ratio used by the author to measure population growth is the number of future mothers born to the mothers of the present generation during the child-bearing period. This is the "net reproduction rate." In recent years this stood at 1.70 for Russia, 1.40 for the Ukraine, 1.30 for Bulgaria, 1.30 for Hungary and Czechoslovakia, east, .95 for Czechoslovakia, west, .90 for Latvia, .80 for Austria, and .65 for Esthonia. In spite of Premier Mussolini's efforts, the birth rate of Italy declined from 26.8 in 1926–1928 to 25.2 in 1929. It rose in 1930 to 26.0. There would seem to be real cause for Fascist alarm in the author's conclusion that although Italians are reproducing themselves now, "if fertility and mortality should continue to develop for another decade as they have in the past decade, the population will no longer hold its own."

Russia stands out as the country of high fertility. Although it has declined in the Russian cities, "as long as the rural population maintains its great fertility, the trend in the cities is numerically an almost negligible quantity and there is so far no sign of a decrease of fertility in the rural districts while on the other hand mortality still is on the downward path."

To those anxious to learn the truth about population growth, so often seen through the distorting lenses of superficial analysis, this and the other volumes will be more than welcome.

NEVA R. DEARDORFF

The Welfare Council of New York City

Statistical Contributions to Canadian Economic History: Vol. I, *Statistics of Banking*, by C. A. Curtis; Vol. II, *Statistics of Foreign Trade*, by K. W. Taylor; *Statistics of Prices*, by H. Michell. Toronto: The Macmillan Company of Canada, Ltd. 1931.

These two volumes represent the result of coöperative research undertaken by members of the Economics Departments of Queen's and McMaster Universities and financed by the two Universities, the Social Science Research Council, and "a number of business corporations and private individuals." The student of Canadian economic history will be eternally grateful to the authors and sponsors who have thus made available in convenient and usable form quantitative records of the three perhaps most important phases of Canada's economic activity, records not previously available in any single library, and here assembled and systematically arranged only at the expense of painstaking industry.

For those interested in the business cycle, the many series here presented, extending over the first 63 years of Canada's nationhood, provide, as Dr. Mackintosh remarks in his Introduction, an excellent opportunity to study the workings of the business cycle in "an immature economy," to note the changes from the early period when the cycle is generated externally and communicated to the young community only through its external trade and its borrowings of capital to the later period when the cycle is in part generated internally, and to test the hypothesis that a steeply upward secular trend stimulates early recovery from periods of depression and increases the relative length of the prosperity phase of the cycle.

As the analysis of the statistical series has not been pushed far in most cases, this review must content itself with a brief survey of the contents of the volumes. In Volume I, Dr. Curtis has brought together for the first time the available statistics of Canadian banking since 1867 (and also in the case of Ontario and Quebec from 1850 to 1880). In detail and completeness these are probably not excelled by the banking statistics of any other country. For these merits we have to thank the early introduction of the system of monthly returns by all chartered banks to the Dominion Government and the fact that in Canada the chartered banks do practically all of the savings bank as well as all of the commercial banking business. As time has gone on the detail required by the

Government schedules has steadily increased. Not the least valuable of the contributions made by Dr. Curtis is an excellent discussion of the historical development of these returns, a careful explanation of each asset and liability item required by the return from time to time, and a "key" summarizing the historical changes in each item. This analysis should save the student from many pitfalls of interpretation. The quantitative data include 28 tables of liability items and 47 tables of asset items covering the whole period since Confederation, 30 tables giving the asset and liability items for the banks of Ontario and Quebec for the period 1856–1880, 14 tables of selected items expressed as percentages of total assets for the system, and a table showing the amount of Dominion Notes outstanding with the gold held against them by months since 1867. A series of ten charts is included but only brief interpretation is attempted.

Of no less importance for a study of Canada's economic history are her statistics of external trade and of prices, which provide the content of Volume II. The assembling, interpretation, and orderly arrangement of these statistics similarly required painstaking care and the most careful judgment.

Professor Taylor's chief contribution consists of a thorough reclassification of the country's export and import statistics for the period 1869 to 1915. Homogeneous series for 9 major groups and many sub-groups are presented on a yearly basis. Not only are actual declared values given for each item but the influence of fluctuating price levels is eliminated by revaluing all the individual items in terms of their 1900 values. As a by-product of the process of expressing all imports and exports in "1900 dollars," index numbers of import and export prices were obtained and are presented along with a brief discussion of the changes in Canada's "net barter terms of trade." Professor Taylor also attempts an analysis of the relationship between the balance of trade and prosperity in Canada. For this purpose it was necessary to construct an index of prosperity by adding together indexes (in the form of percentages of a seven-year moving geometric average) of railway freight traffic, beer consumption per capita, the Ontario marriage rate, stock exchange prices, physical volume of production, volume of employment, bank loans and bank deposits (corrected for changes in the general price level). It would not be difficult to pick flaws in this index but it is regarded only as a "rough and ready" indicator of the ups and downs in Canadian economic life since 1870.

Professor Michell has made a valuable contribution in carrying our price statistics back beyond 1890 from which year dates the pioneer work of the Dominion Statistician, Mr. R. H. Coats. The main compilation comprises monthly prices of 70 commodities for the years 1868 to 1889 but this is supplemented by partial monthly prices for 20 agricultural commodities 1848–1857, by yearly index numbers of 15 foodstuffs 1848–1913, by monthly index numbers of 35 commodities 1868–1918 and by yearly index numbers of 70 commodities by major groups 1868–1925. In a brief introduction, Professor Michell discusses agricultural prices in Canada from 1848 on, the character of the new price data which he has made available and the index numbers based upon them, and the course of wholesale prices since 1868. The volume concludes with an able statistical analysis by Professor W. B. Hurd, of the average sequence, amplitude and duration of price revival and recession in the case of 47 individual commodities during the period 1808 to 1913.

W. C. Clark

Queen's University

Problems in Business Statistics, by Theodore Henry Brown. New York and London: McGraw-Hill Book Company, Inc. 1931. 500 pp.

This new "Harvard Case Book" is designed, according to the author's preface, to "meet part of the *why* of business statistics . . . details of statistical methods have been made subservient to the question of why statistics should be used in connection with various groups of business problems . . . the text presents a cross section of the research and experience of business houses of today." In other words, not the *why* but the *where* and *what* of business statistics are described in this volume.

The statistical summaries currently used in business are, in the main, of an elementary nature. Hence, the book consists primarily of examples of the use of such averages and ratios as are commonly employed in analyzing past sales, in controlling distribution, in making market analyses and sales quotas, in comparing the fluctuations of individual businesses with those of general business activity, in evaluating depreciation and other production costs, and in setting up standards for the statistical control of inventory, quality, and price. By pointing out the large number of problems now being currently solved by the aid of statistical weapons, the volume tends to sell statistics to the business man.

The cases have been selected with remarkable skill. Though some are of the scrap book variety, an unusual number are substantial and intriguing, more so because they require a thorough knowledge of statistics before the student is competent intelligently to handle them. They serve admirably as teaching material *after* students have been grounded in the elements of method. Though some of the cases have an answer that is almost too obvious, a goodly number, fortunately, offer considerable scope for difference of opinion. These not only provide excellent thinking media, but they have the supreme merit of realism, for, needless to say, the answer to most business problems is usually neither obvious nor single.

In one respect, however, the volume is disappointing. It does not contain enough examples of what not to do in statistics. The beginner who has acquired a first familiarity with the mathematical tools of statistics frequently overestimates the quality and field of their utility. For that reason candidates for business should not only be sold on statistics but should also be taught an intelligent statistical sales resistance. More cases of clumsy, inaccurate, and misleading statistics should have been included. Though such case material of statistical pathology is difficult to obtain from businesses (none of us advertises our failures) it could have been easily obtained from current business publications. In a day when business men must encounter statistics "gone wrong" almost hourly, it is of utmost importance to teach students when *not* to use statistics.

Occasionally one finds curious contrasts. On page 19, for example, we read "many people in discussing statistical summaries with business men phrase their discussion in terms of technical procedure. Such phraseology the business man justly resents. Consequently, the emphasis here is placed primarily upon the *results* to be derived in a given problem rather than upon the *method* of getting those particular results." On the same page, however, there occur without preliminary explanation the following terms: arithmetic grid, semi-logarithmic grid, correlation, time series analysis, index of seasonal variation, cyclical fluctuations.

Moreover, the doctrine is dangerous. It seems to me that the main emphasis in any course in statistics should be upon interpretation. Persistently and continuously, students should be made aware in business statistics of the limitations of the sources, of the methods, and especially of the data. Altogether too many statisticians in business guess at the diameter of a circle, and secure the circumference by multiplying by π to fifteen places.

The reason for the excellences and defects of the *Problems* is contained in the author's preface. He states "man has developed his knowledge of applied science first through experiment, then through the practice of recognised procedure. Finally out of repeated applications of the procedure he has developed an underlying philosophy." According to this view of the progress of science, experiments and facts come first, and a philosophy of the subject is epiphenomenal. Now whether facts precede theory, or theory is necessary before an investigator can know what are facts, is, of course, an old controversy which I do not propose to open here. But it must be pointed out that the history of all the experimental sciences shows in the *usual* instance that philosophy comes first. By its aid the investigator selects what for his purposes are facts, and *creates* methods of experiment. He comes to the facts with idea after idea, and finally verifies one. He puts questions to the facts and the facts put questions to him.

So, in statistics, it is first of all necessary to be a thorough master of whatever statistical philosophy there is, *not only in order to avoid mistakes, but in order* to do further pioneering. Though at present statistical philosophy is still very much in the making, I do not believe that we should wait till there "appear presently the outlines of a basic philosophy of business statistics." Certainly we should not ignore nor neglect that which we already have. It seems to me that a complete treatise on business statistics will abound in interpretative danger signals, particularly in its discussions of method. It will make a survey both of what is being done and of what could be done. Then the student going out into business will not only be *au courant* with the semi-recent business practice of his case book but will also be able to suggest new fields for old methods and new methods for old fields. In this wise he will secure the best kind of preparation for successful participation in a game in which all is change.

THEODORE J. KREPS

Stanford University

Some Recent Researches in the Theory of Statistics and Actuarial Science, by J. F. Steffensen. Cambridge University Press, Macmillan Company, 1930. 48 pp.

This little book is based on the substance of three lectures delivered by the author in London University in March, 1930. It marks a continuation of the admirable work by this author in introducing more mathematical rigor into methods of numerical approximation in statistical and actuarial science. The first lecture is a discussion of three examples showing how obvious errors may arise by failure to observe the principle that "observations may contradict each other, owing to unavoidable errors of observation, but mathematical relations are not allowed to contain contradictions." The nature of a mortality table is discussed with reference to the determination of the "oldest age." The author shows that from the point of view of mathematical methods the limiting age in the table should be determined not by the accuracy of the underlying data, but by considering the error committed in calculating sums and integrals to the oldest age instead of to infinity.

The author then proceeds to discuss some of the accepted methods of finding presumptive values of frequency constants in statistics. His conclusion that neither of the two systems of Thiele and Tschuprow is free from contradictions is likely to elicit considerable discussion among statisticians.

The second lecture, on the subject of interpolation, calls attention to the need of the use of remainder terms in determining the accuracy of interpolation formulas. The third lecture discusses the theoretical foundation of various types of frequency functions including Pearson's types, the A-series, based on the normal error function, and Charlier's B-series. The inclination of the author is toward the view that the apparent generality of the series representation has disadvantages and that the Pearson's type curves are, as a rule, preferable.

W. O. Menge

University of Michigan

The Japanese Population Problem, by W. R. Crocker. New York: The Macmillan Company. 1931. 240. pp.

In the light of what has happened in Manchuria and Shanghai during the past few months, this book should be of especial interest to both scientist and statesman. Mr. Crocker reaches much the same conclusions concerning Japan's population problem as did Dr. Warren S. Thompson in his book, *Danger Spots in World Population*.

The population of Japan proper numbered over 62 million in 1928; in 1878, fifty years before, it was only half this figure. For the period 1921–1925 the birth rate of Japan has averaged 34.3 per thousand population, while the birth rate in England for the same period was 19.9, and in Germany 21.8. Since 1922 more than six million have been added to the country's inhabitants, that is, more than the entire population of Australia.

There are nearly 1,000 persons to every square kilometre of arable land in Japan; in Holland, where the numbers are highest for Europe, there are 800, while agriculture is of distinctly less importance to Holland than Japan. The arable land per farmer and his family is three times as great in Italy (3.1 acres) and thirty times as great in the United States (31.7 acres) as in Japan (0.9 acres).

The silk industry is indispensable to Japan, and Japan is dependent upon two countries, i.e. the United States and China for her export trade. Nearly half of

Japan's exports consists of natural silk—raw, spun, and cloth—and a quarter of cotton, while two countries, the United States and China, take two-thirds of the total amount.

The Japanese foreign policy, the author believes, will be determined by her population problem. To say that is to regard her population problem as the dominant issue in the Pacific Region. While Mr. Crocker agrees with Dr. Thompson that emigration in the absence of birth regulation would merely stimulate the birth rate of the emigrant-exporting country and the conditions would probably be worse than before, he also agrees that Japan may be legitimately interested in emigration for she is experiencing both a decline in her birth rate and a rise in her conception of the standard of living.

Not only is Japan the most overpopulated power in the world today, but her population has gained such a momentum that Japan cannot possibly solve her population problem in a peaceful manner unless the powers come to her aid with territory until she has time to stabilize her population growth.

It is difficult, according to Mr. Crocker, to resist the conclusion that the powers —if only in their own interest, for in any case they cannot ignore the international repercussions of Japan's domestic situation—should combine at the fitting time to place Borneo or/ and New Guinea and some Pacific islands (in whole or in part) at her disposal. The British Empire and the Netherlands, for example, might transfer Borneo (or some part of Borneo) to the League of Nations, which in turn might confer it on Japan as a Mandate. In a similar way the Marquesas, in the South Pacific, might be handed over to her. In the case of Brazil (and possibly other Latin American countries too) and perhaps also in the case of Siberia, satisfactory arrangements may be made with the sovereign States concerned without any concerted international action.

It ought to be practicable to dispose of not less than 50,000 to 100,000 emigrants a year, and 50,000 to 100,000 a year may be "the little more or the little less" that may save the peace. It was the last straw, concludes Mr. Crocker, that broke the camel's back.

Guy Irving Burch

Population Reference Bureau

The New England Cotton Textile Industry, A Study in Industrial Geography, by J. Herbert Burgy. Baltimore: The Waverly Press. 1932. vii, 246 pp.

This is a careful and a useful book. The author, in approaching the New England industry from the point of view of geography, has wisely refrained from trying to weight too heavily the influence of physical factors on the later history of the industry. In the early localization of the New England plants the great importance of transportation, power, and labor supply are brought out neatly. Geographical theses are established for the South Shore points, notably Fall River and New Bedford, by showing the influence of the terrain, the climate, and sea communications in bringing the industry there to the fore. In proportion, however, as southern competition looms in the textile picture, the importance of geographical differences within New England lessens, and questions of regional cost, which the author has chosen to regard as mainly "economic," become paramount.

Comprehensive data on most of these differential costs have been lacking, and the tables given here, while fragmentary, are welcome. Burgy finds slight advantages for the southern mills in freight charges on raw cotton (offset by hauls of piece goods to the North) cheaper coal in the South, and a labor cost advantage which he places as high as thirty per cent. Charges for purchased electric power North and South are not compared. New England's old advantage in its humid spinning-climate is elaborately shown, though the perfected humidifying devices are acknowledged to have made the difference now of little effect. New England retains the considerable stimulus of proximity to the New York styling and marketing centers, her trained labor, and the crisper climate. Although the South is presented as advancing in fine goods production, the author expects that certain northern centers will long hold their lead, especially if northern local taxes can be reduced.

The book is full of information that is ordinarily hard to come by; there are revealing bits about the history of particular firms or towns, and good statistical summaries are given, for example, of the kinds and qualities of goods made in the more important regions, of the extent of company housing in New England, and of the national origins of the New England and southern labor forces.

It does not require much imagination to see many of the factors which Burgy classes as "economic" pat over into terms that are fundamentally geographic. Further studies on the order of this one would give needed light on the question, important in this industry and in many others, as to what part of the differential in costs in old and new centers is rightly ascribable to direct geographic influences on cost, including labor costs, and what part to advantage taken of social and historical accident.

George Sinclair Mitchell

Columbia College

Population Characteristics by Census Tracts, Cleveland, Ohio, 1930, by Howard Whipple Green. Cleveland, Ohio: The Plain Dealer Publishing Company. 236 pp.

To secure the data for the decennial Census of Population costs the people of the United States many millions of dollars. The data gathered cover in great detail nearly every city and community in the nation. Many of the facts revealed by the inquiry are, however, normally tabulated only for the state or city as a whole, and not for localities—the reason being that such tabulation is too expensive for the Bureau of the Census to undertake. It follows that many of those results of the Census enumeration which are of the greatest potential importance never see the light.

The officials of the Plain Dealer Publishing Company felt that the facts collected by the census enumerators were too valuable to remain buried in the files of the Census. They, therefore, paid that Bureau to tabulate the most important data for each of 252 census tracts located in Cleveland and its suburbs.

The work of putting these tabulated facts into a form which the intelligent public could comprehend at a glance was assigned to Howard Whipple Green. He has been highly successful in carrying out this plan.

The results of his work are presented in an elaborate volume which contains not only a detailed tabulation of data for the various census tracts but also a fine collection of statistical maps and other graphic charts illustrating in a forceful way the salient facts brought out by the census inquiry.

In these charts, he has shown such facts as the changes occurring between 1920 and 1930 in the population density of the various sections of Cleveland, the age distribution of the population in the various districts, the age distribution for various nationalities, the changing residential location of the Negro population, the geographical distribution of each of the leading groups of foreigners, the distribution of illiteracy and unemployment by districts, the percentage of families in each census tract owning homes or radios, and the relationships of juvenile delinquency, births, and infant mortality to average monthly rental values of homes in the various sections.

Among facts of general interest brought out by the investigation are: (1) Home ownership increases with the average income of the people; (2) Unemployment, both in 1930 and 1931, was far more severe in the poorer than in the more well-to-do sections; (3) Illiteracy among the native born is confined almost wholly to the poorer sections of the city; (4) Three-fourths of the foreign-born residents of the well-to-do sections are American citizens while only one-third of the aliens in the poorest sections have become naturalized; (5) In the poorest areas, most heads of families are either Negroes or foreign-born whites; (6) Juvenile delinquency is ten times as common in the poorest as in the richest sections of Cleveland; (7) In the poorest districts, the birth rate, the general death rate, and the infant mortality rate are all more than double what they are in the well-to-do sections.

This book will prove a boon to Cleveland social workers and will be of great assistance to all administrative officials in that city. When leaders in other centers of population see what has been accomplished for Cleveland, it is probable that they will be anxious to gain a like understanding of the situations prevailing in their respective communities. Should such be the case, they will find in Mr. Green's work an excellent model, which they may copy to their advantage.

WILLFORD I. KING

New York University

Handbook of Statistical Nomographs, Tables, and Formulas, by Jack W. Dunlap and Albert K. Kurtz. Yonkers-on-Hudson, New York: World Book Company. 1932. vii, 163 pp.

Some of the first nomographic devices were represented by the so-called "Astrolabes"—instruments used for the taking of altitudes of heavenly bodies, from which time and altitude are deducible. One of the best known and most beautiful examples is Humphrey Cole's Astrolabe (1574)[1] which uses a rotable

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[1] *The Encyclopaedia Britannica*, 14 Ed., Vol. 2, p. 575.

"alidade" or diametric rule with sights turning within a circle of degrees for measuring the altitude of sun and stars. The sun dial is also essentially a nomographic device.[1]

The publication of Léon Lalanne's basic paper "Sur les tables graphiques et sur la géométrie anamorphique,"[2] was followed by "Coordonnées parallèles et axiales" (*Nouv. Ann. d. Math.*, 1884) by Maurice d'Ocagne, and later by the comprehensive "Traité de Nomographie—Théorie des Abaques" of the same author.

Since then the wide interest in the nomographic method can be shown by the fact that many publications on this subject have appeared from time to time in various parts of the world; for example, in Rome, New York, Berlin, London, Paris, Madrid, Bucharest, and numerous other cities.[3] Most of these publications deal either with the method or with specific applications of the method to engineering problems. The *Handbook of Statistical Nomographs, Tables and Formulas* by Dunlap and Kurtz is as far as the writer knows the first book to deal with nomographs pertaining to the nomo-graphic computations of statistical constants. The volume is divided into three parts: Part one, "Nomographs," part two, "Tables" and part three, "Formulas." Twenty-eight nomographs are given in the first part and in substance relate to the graphic computation of various measures of reliability. For example, nomograph on page 5 refers to the standard error of the mean expressing the relationship $\sigma_M = \frac{\sigma}{\sqrt{N}}$ with σ and N given, σ_M can be computed at once by placing the hairline of the celluloid strip, furnished with each volume[4] over the scale values of the given units of the right-hand and left-hand nomographic scale of the diagram, the intersection of the hairline with the center scale, representing the values of σ_M, furnishes the desired magnitude of the unknown σ_M.

In his introduction the editor points out that "although the contents have been determined primarily by a consideration of the needs of workers in the field of educational and psychological measurements, the book will be found hardly less useful to statistical workers in other fields." Previously the editor states: "A large part of the computational work done in statistics is carried out by methods as antiquated as the ox team or wooden plow." The writer fully realizes that it would be very desirable to devise real short-cut methods, but does the nomograph, in the case of statistical computations, represent such an enormous time saver? We have to consider two basic conditions in the case of the application of nomographs: The first general case represents itself in the domain of engineering, physics or biology, where experimental data have lead to the derivation of a basic formula. For example, in the case of the Du Bois equation $S = 71.84 \cdot W^{0.425} \cdot H^{0.725}$, where S = surface in sq. cm., W = weight in kg. and H = height in cm. (all relating to the human body). The weight and height are given at once and therefore the computation of S, which is dependent upon the multiplication of one constant and two variables with constant fractional exponents, can be immediately determined from the nomograph. However, in the case of most statistical measures of reliability, correlation, etc., generally 80 to 85 per cent of the time required for computing these measures is consumed by the computations of the summation expressions connected with the variables, for example, such algebraic terms as $\Sigma x.\log y$ and $\Sigma x^2 \log y$. These factors must be computed *before* they can be entered in the nomograph. No doubt the idea of the nomographic approach as a time-saving device must have occurred to numerous workers in the statistical field, but their projects probably did not materialize for the above given considerations.

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[1] H. Schwerdt, *Lehrbuch der Nomographie auf abbildungsgeometrischer Grundlage*, Berlin, 1024, Julius Springer, p. 38.

[2] *Ann. d. Ponts & Chaussées*, Paris, 1840, 01 pp.

[3] *Encyclopaedia Britannica*, 14 Ed., Vol. 16, pp. 483, 484.

[4] For use with the nomographs the publishers have provided a celluloid strip with two scales and a "hairline." It seems unfortunate that the use of the reference line "AA" has been made very difficult by printing above and below it: "For use with Dunlap-Kurtz Statistical Nomographs—World Book Company, Publishers." This advertisement continually interferes with the reading of the various nomographic scale units when required values must be taken. It would be just as inappropriate to have a trademark etched on the glass body of a lens by some over-zealous promoter of optical instruments.

A praiseworthy feature of the book, besides having a good typography, is represented by part three entitled: "Formulas" and "Errors Found in Published Formulas." The 434 formulas given are written in uniform notation, in which each symbol has only one meaning. Thus, x means a deviation from a mean in every formula in which it occurs,[2] and finally on page 117 we find a list of formulas which were published in other books and which, according to the authors, contained errors. Such patience and diligence deserve praise and serve a useful purpose. Part two—from page 69 to [illegible]—contains various tables and constants, frequently used in statistical methodology. The tables of Frederick C. Mills and Donald H. Davenport[3] and Frank Alexander Ross[4] should have been included in this section. These tables refer to the summation of the natural numbers, and represent great time savers for statistical computations. An exhaustive bibliography referring to the best-known works on nomographic methods would also have been a logical addition.

R. von Huhn

The Competitive Position of Coal in the United States. New York: National Industrial Conference Board, Inc. 1931. xvi, 288 pp.

This book is another addition to the long list of literature and statistics on the coal industry of the United States. Since medical doctors devote most of their attention to the sickest patients it is not surprising that the economists and statisticians have devoted much of their attention to the coal industry. But, as frequently happens, the doctor is only able to tell the patient how badly off he is. So, with this book, the authors have devoted most of their attention to explaining how sick the coal industry is.

The authors, in fact, have gone into great detail to explain what is wrong with

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[1] Raymond Pearl, *Introduction to Medical Biometry and Statistics*, Philadelphia and London: 1930, W. B. Saunders & Company, p. 104, Fig. 55.

[2] See introduction, p. 101.

[3] F. C. Mills and D. H. Davenport, *A Manual of Problems and Tables in Statistics*, New York (1925), Henry Holt & Company, p. 197.

[4] Frank Alexander Ross, "Formulae for Facilitating Computations in Time Series Analysis," this JOURNAL, Vol. XX, New Series 140, March 1925, pp. 75-79.

the coal industry and why, and conclude with some suggestions for a "constructive economic policy." The analysis of the competitive position of coal is divided into four parts. The first part describes the position of the United States in the world coal industry. The second part is an elaborate analysis of coal consumption by major uses. Each of the major uses for coal is discussed separately, the competition with other sources of energy is weighed carefully, and a forecast for the future is made. The third part deals with the consumption of coal by regions. The regional analysis, also, describes the competition of coal with other forms of energy in particular regions and briefly notes the future outlook. Part four is a survey of the competitive problems and policies in the coal industry with emphasis on reserves, mine capacity and mechanization.

The possibility of a constructive economic policy is outlined in the last chapter. Here, as frequently happens with the medical doctor, about the only thing to do is "let nature take its course," that is, in lieu of government control of production and prices, let the "automatic" checks of competition have their fling.

The book is well supplemented with tables and charts and would serve as a handy reference book on the intricate problem of the competitive position of coal.

W. H. YOUNG

Health Center Districts—Statistical Reference Handbook. Department of Health, City of New York, Committee on Neighborhood Health Development. 1931. xiv, 59 pp.

This handbook contains vital statistics data for 30 districts of New York City, including valuable basic information assembled for the first time. The Committee on Neighborhood Health Development has demonstrated, through this channel, the value of carefully assembled statistical data, district by district, as an aid in planning for localized or neighborhood public health services. This information, graphically presented, makes it possible to visualize health conditions in various sections of the city.

The data contained in the handbook include, for each of the 30 districts, population, school registration, vital statistics with rates, including births (corrected for residence), deaths from all causes, registration of new cases of pulmonary tuberculosis, syphilis, gonorrhea, and other communicable diseases, existing hospital and clinic facilities, transportation facilities, and public health nursing requirements.

The complexity, as well as the diversity, of the problems of the various districts becomes apparent when the data are studied. Density of population varies from a little less than 3,000 per square mile in one district to slightly less than 85,000 in another. The general death rate for the city as a whole was 10.7 in the two-year period 1929-1930. The rate for Manhattan was 13.6; for the Bronx 8.6; for Brooklyn 10.2; and for Queens 8.9. Similarly, infant mortality varied by boroughs, with an even greater diversity for the smaller health districts. The statistical data and excellent maps render this handbook an indispensable aid in program planning.

IRA V. HISCOCK

Yale University

Struktur und Rhythmus der Weltwirtschaft, by Dr. Ernst Wagemann. Berlin: Verlag von Reimar Hobbing. 1931. xxvi, 412 pp.

Dr. E. Wagemann, Director of the Institute for the Business Cycle Study of Germany, is well known to American readers as the author of the book *Economic Rhythm*, recently published in English. In his new book Wagemann returns to the same problem but in its international aspects. From this point of view Wagemann classifies all economic regions of the world into four groups: mature-capitalistic, neo-capitalistic, semi-capitalistic, and non-capitalistic countries, and he presents the statistical characteristics of each of these groups. He also analyzes these different economic systems as to their sensitiveness to business fluctuations. It is of interest that Wagemann considers that restricted economies (profit or capitalistic restricted economies as well as communistic) are also subject to conjunctural fluctuations. He doubts that even a communistic system would be free from crises. As to a restricted profit economy, where some branches of activity are controlled and others are ruled by free competition, he regards such systems as particularly responsible for the accentuation of business fluctuations. In the opinion of Wagemann the factor especially responsible for great fluctuations, and particularly for the gravity of the present depression, is the coexistence of different economic systems in different stages of development and only mechanically connected with one another through international trade.

After a demonstration of the world interconnection of various elements of the business cycle, Wagemann undertakes the quantitative analysis of international trade and its fluctuation. Using statistical data on world trade published by the German Institute for the Business Cycle Study,[1] he demonstrates the cyclical character of the fluctuation of world international trade during pre-war times. These cycles depended mostly upon price fluctuations since the quantum of world trade showed cyclical fluctuations of smaller amplitude. Dividing the world trade into two parts—that of European highly-capitalistic countries on the one hand and of agricultural and raw-material-producing countries on the other it appears that the imports of industrial countries manifested the most marked cyclical fluctuations. For agricultural countries exports had the more pronounced cyclical character. Wagemann explains this by the fact that the greatest part of world trade consists of the exchange of the manufactured goods of industrial countries with the food and raw materials of agricultural countries. As imports of industrial countries are affected by the business cycle, those of agricultural countries are exposed to the same cycle. The causal relationship seems to me to be the reverse. As I have shown in an examination of American and Russian exports,[2] cyclical fluctuations of exports in agricultural countries reflect crop cycles. Large crops cause exports large in quantity and in value, though at low unit prices. These cyclical fluctuations of exports from agricultural countries may explain not only cyclical fluctuations of business in agricultural countries, themselves, but also the business cycle in industrial countries importing food and raw material. D. H. Robertson and K. Zweig have attributed English industrial fluctuations in part to the fluctuation in its foreign trade with agricultural countries. Wagemann, on the contrary, believes (p. 480) that the economic fluctuations in agricultural countries depending upon crop fluctuations have no direct relationship to industrial fluctuations, and that "industrial crises arrive sometimes quite independently of agricultural crises." We accept this statement, but agricultural crises and agricultural fluctuations of shorter terms are quite different phenomena. Agricultural crises are rather infrequent and are connected, presumably, with the long waves of cycles, while agricultural fluctuations of shorter terms may be considered as one of the important factors causing business fluctuations, as was demonstrated by us for the United States, particularly for pre-war times. Of further interest from this point of view is the fact, supported by Wagemann's statistics, that balances of trade of industrial and agricultural countries have a tendency to fluctuate in opposite directions.

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[1] Soltau, "Statistische Untersuchungen über die Entwicklung und die Konjunkturschwankungen des Aussenhandels," in der *Vierteljahrshefte zur Konjunkturforschung*. Erg.-Heft 2, 1 Jahrg. 1926.

[2] See V. P. Timoshenko, "The Rôle of Agricultural Fluctuations in the Business Cycle," *Michigan Business Studies*, Vol. II, No. 9, 1931, pp. 25–31. Also V. P. Timoshenko, "Wheat Prices and the World Wheat Market," Ithaca, New York, 1930, pp. 62 ff.

Wagemann finally analyzes the post-war cycles. The causes of the present depression he classifies into two groups: the monetary and the commodity factors. The depression in America was not, he believes, caused by difficulties of capital supply; in neo-capitalistic countries which export agricultural products and raw materials, the deficiency of capital cannot be considered as the prime cause of the recession, because the recession in these countries started at the time when long-term capital inflow was still growing. The data presented by Wagemann in his book (pages 322–323) are not sufficient to support his statement, and it would be valuable to study with more detail the causes of recession in agricultural and raw material producing countries, which presumably were the cradle of the depression.

Wagemann thinks that conditions in Germany were different and that the deficiency of capital reserves there was, perhaps, first responsible for the recession; however, he says that it would be too risky to explain the world-wide crisis in terms of the deficiency of capital in Germany. For these reasons, Wagemann sees the major causes of the present depression in the overproduction of agricultural and industrial products and in overinvestment. He emphasizes the fact that recent investments were mostly of an "intensive" character, of a rationalization of the productive processes, with the purpose of eliminating, as much as possible, human labor. Such types of investment are especially dangerous from his point of view because they create underemployment as well as overproduction.

The leading idea of Wagemann, that the world economic rhythm should be explained through the interrelationship among countries of different economic structure and that the post-war changes in this structure have tended to intensify business fluctuation, deserves great attention and further examination.

V. P. Timoshenko

University of Michigan

Hours of Labor, by Lazare Teper. Baltimore: Johns Hopkins Press. 1932. 92 pp.

The earliest industrial communities the world over adopted as the normal work day the sunrise-to-sunset system then prevalent in agriculture. But everywhere, the gradual introduction of machine processes, bringing with it immeasurably large increases in productivity, coupled with insistent demands for shorter hours by the working classes and forces of reform in the interest of health, safety, morale, general welfare, and profits, brought about a gradual restriction in the working day and the working week. Legislation, especially in the United States, had only little to do with the movement and that little chiefly by way of affording protection to women and children and by incorporating into the law what had otherwise already been widely accomplished.

Mr. Teper's study concerns itself only slightly with the above aspects of the movement for shorter hours and concentrates upon the measurements of that movement in the United States between 1890 and 1928 (Part II) and the relationship that existed between the hours of labor and various other factors in the manufacturing industries of Baltimore in 1928 and the state of North Carolina in 1925–1926 (Part I).

In the first part of the monograph Mr. Teper submits his material (consisting of data on the size of establishments, hours of work and some wage information, covering firms employing five or more workers) to a statistical analysis which consists mainly in determining averages (medians) of such factors as hours of work, etc., and constructing correlation tables for the purpose of ascertaining whether there existed a determinable relationship between any two of these factors. He concludes that "the Maryland and North Carolina figures do not confirm the hypothesis" (set up by H. L. Moore and others) "that the size of the establishment affects the hours of labor favorably or unfavorably"; that there is a tendency for the hourly rates of wages to vary inversely with the number of hours of work; that in North Carolina the median daily remuneration in no case is higher in plants working longer hours than in shorter-hour plants; and that "in Baltimore there seemed to be a tendency for establishments working either shortest or longest hours to employ mostly men."

The second part consists of an attempt to revise and bring up to date the studies on hours of work made by I. M. Rubinow and P. H. Douglas and F. Lamberson. Though the author uses data which, in scope, differ somewhat from those employed by his forerunners and a statistical technique which is far less refined (simple arithmetic averages of relatives) the results are surprisingly similar. Mr. Teper's index of hours in no case differs from Professor Douglas' by more than two points, the average deviation being one point. All of which should not necessarily be taken as corroborating evidence of the correctness of either index. Objections could be raised as to the representativeness of the data and as to the purpose which is served by piecing heterogeneous material together by either of the two methods employed—or by any other method for that matter.

An example may serve to explain. Among the eleven industries included in Mr. Teper's sample is one industry called "Marble and Stone." For the period 1890–1907, the author uses data derived from employment and payroll statistics collected by the United States Bureau of Labor Statistics which show a decline in the hours of work from 54.7 per week to 50.4 or 8 per cent. From 1907 to 1928 he employs the United States Bureau of Labor Statistics data on "Union Scale of Wages and Hours of Labor" which show a decline of some 1.7 per cent during that period, making a total decline of 9.6 per cent (see table 5). We should, therefore, expect the full-time week to have declined from 54.7 hours in 1890 to 49.4 hours in 1928. Instead, table 10, giving "average full-time hours of labor per week in eleven industries in 1890 and in 1928," has 44.0 hours, the published United States Bureau of Labor Statistics figure for Marble and Stone, or 19.6 per cent below the 1890 figure, instead of the 9.6 per cent indicated by the index number. Under the column headed "per cent decrease during the period" the figure given is indeed 9.6 per cent but that undoubtedly is a typographical error.

DAVID WEINTRAUB

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POPULATION CENSUSES BEFORE 1790

By A. B. Wolfe, *Ohio State University*

A population census, in the correct and specific sense, is a direct enumeration, preferably on a set date and by name of each individual in the census area. A census so made is both enumerative and "nominal." In most countries regularly recurring enumerative and nominal censuses are of comparatively recent origin. Before 1861 the number of European countries which had such censuses could be counted on the fingers of one hand. It is commonly thought that the idea, as well as the execution, of an enumerative census was started by the United States in 1790. The truth is that the idea of a complete enumerative population census was then by no means novel. The federal census of 1790 was preceded by various colonial censuses; the first Canadian census was taken in 1666; from 1749 on there was in Sweden a continuous registration system, which, while not an enumerative census, was a fair substitute; and certain Italian states had enumerative and nominal censuses as early as the sixteenth century.

While the term census should be confined specifically to complete nominal enumerations, it is frequently used in a more generic sense, covering also partial enumerations, of heads of families, hearths, male citizens of military age, etc. With the exceptions above noted, the "censuses" of all countries before the nineteenth century were based on such partial enumeration, supplemented by estimate of the unenumerated portion of the population. Such estimates are never more than approximate and are usually subject to a wide margin of error. Arbitrary coefficients for estimating the total population from enumerated heads of families, hearths, and the like, are necessarily employed, and the result, however credible as an estimate, cannot take the place of a direct summation of original and complete enumerative data. While sharp distinction should be made between a census which is the result of complete enumeration and one which is partly the result of estimate, it is not always easy to say when a country made its first reliable census, since the two types grade into each other and even where a complete enumeration is ordered it is not always effectively carried out.

REGISTRATION AND CENSUSES IN ANCIENT TIMES

What little quantitative knowledge we have of population in ancient times is derived from registration of heads of families, taxpayers, and men of military age. Reports of "enumerations" in Babylonia and Egypt cannot be taken seriously.[1] Registers of births and deaths are said to have been kept in Egypt from very early times, and by 1400 B. C. an elaborate registration system, covering all heads of households, together with all members belonging to the household, was in force.[2] It does not appear, however, that the Egyptian registration was ever summated for the whole country. It is unlikely that the complete registration which Breasted finds in the fourteenth century B. C. lasted continuously through the vicissitudes of Egyptian history, though it comes to light again in Herodotus's account of Amasis II (570–522 B. C.).

The so-called censuses among the Biblical Hebrews were at best only partial enumerations for fiscal or military purposes. The first "census" Biblically recorded was that by Moses and Aaron during the wanderings in the wilderness, perhaps about 1500 B. C. No further count is recorded for about five centuries, when David ordered his famous census. This was not an enumeration in the modern sense, but only a count of the men of military age.[3] The Biblical account of the Lord's wrath at the taking of this census[4] remained an argument against census taking even as late as the eighteenth century. The captains of the host evidently did not have an easy job, for it took them over nine months to make the count. Schnapper-Arndt ventures to think that the anger of Jehovah was less against the census itself than against the slovenly way in which it was carried out.[5]

Knibbs states that in China "statistical results" date back to 3000 B. C. An older authority gives estimates of the Chinese population back to 2275 B. C., and of the number of families from 2 A. D.[6] From the first recorded count in 2275 B. C. to 1712 A. D., with few exceptions, only the number of tax-paying households was recorded. From the latter date on, the total number of individuals is purported to have been ascertained.[1] In the first period, since the sole purpose of the count was fiscal, there is reason to believe that the returns were below the true figures. The returns forwarded to the central government were kept low by the local officials, who could thus divert a portion of the tax proceeds to their own pockets. Rockhill points out, moreover, that the returns are uncertain, not only because of official cheating, but also because the meaning of the term household or "hu" is uncertain and changeable. We also do not know the exact meaning of the term for individual, "mouth" or "k'ou"—whether it includes only adult males, adults of both sexes, or persons of all ages, exclusive of infants. The latter were never included in the lists at any period. Similar uncertainties abound in the interpretation of cadastral surveys and other population statistics in Europe from the earliest times to a late date.

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[1] Cf. Sir G. H. Knibbs, *Census of the Commonwealth of Australia*, 1911, Vol. I, p. 1; Kahrstedt, "Die Bevölkerung des Altertums," *Handwörterbuch der Staatswissenschaften*, 4th ed., Vol. II, pp. 658, 659.

[2] Breasted, *History of Egypt*, 1906, p. 165.

[3] I *Chronicles* xxi, 2; II *Chronicles* ii, 17; Knibbs, *op. cit.* According to *Exodus*, xxx, 11–16, Moses was directed to number the people (males over 20 years of age) and levy a poll tax.

[4] Cf. I *Chronicles*, xxi; II *Samuel*, xxiv.

[5] *Sozialstatistik*, 1908, pp. 50, 51.

[6] J. Sacharoff, "Historische Übersicht über die Bevölkerungsverhältnisse Chinas." *Arbeiten der kaiserlichen russischen Gesandtschaft zu Pekin über China*, Berlin, 1858, Vol. II, pp. 127–195.

Coming to Greece, we find nothing that suggests an enumerative census before post-Alexandrian times. Even then we do not have a complete population census. The census of Athens, by Demetrios of Phalerum, about 317 B. C., included all classes of males—citizens, metics, and slaves—but did not include women and children. It is not known how this census was taken or whether there were later Athenian censuses or censuses elsewhere in Greece. Beloch thinks that there is indirect evidence that censuses must have been taken, much later, in the large cities, especially Alexandria. Only in these hypothetical later city censuses do we arrive at the statistical conception of the population as a whole.[2]

According to Herodotus the Egyptian idea of registration was introduced into Athens by Solon. It there developed into a system of continuous record of the electorate. From the fourth century B. C., lists of citizens were engraved on stone and many of them have, therefore, been preserved. Theoretically, a full complement of these lists would enable an estimate to be made of the Attic population, and in fact the fragmentary data surviving from them constitute the only basis for an estimate. They were very far, however, from being anything in the nature of a population census. They did not include the women and children and the slaves. Even the metics, and, apparently, the thetes, were excluded.

In Rome, registration and enumeration of adult male citizens were made from a very early date, even before the Athenian census of Demetrios of Phalerum. The Roman census, however, at least before Augustus, was not a census in the modern sense. In the first census taken by Augustus, 28 B. C., the total was 4,063,000, whereas the total in the last Republican census, 69 B. C., was only 910,000. This great difference is interpreted variously by different historians.[1]

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[1] Rockhill, "An inquiry into the population of China," *Smithsonian Institution, Annual Report*, 1904, p. 659.

[2] *Die Bevölkerung der griechisch-römischen Welt*, 1886, pp. 4, 5.

Censuses were supposed to be made every four years, but practical difficulties caused much irregularity. Before 443 B. C., ten, of doubtful authenticity, are alleged to have been made. From 443 to 318 B. C., fifteen are cited, an average of one every eight or nine years. In the succeeding 233 years, 318–86 B. C., there were forty-one, or one every five or six years. After 86 B. C., sixteen years elapsed without a census, a lapse due probably to the complications arising from the extension of citizenship to the Latin colonies and the Italian allies after the Social War, 91 B. C. Augustus took three censuses, at twenty-year intervals, 28 B. C., 8 B. C., and 14 A. D. Thereafter no census was taken for thirty-three years, when, under Claudius, one was taken in 47 A. D. The last census, the results of which we do not know, was taken under Vespasian in 72 A. D. Italians were now free of taxation and military service, and the census no longer had practical value. In the provinces, however, censuses continued to be taken. Provincial censuses had been made as early as the third century B. C., in Sicily, Sardinia, and Spain, but the provincial censuses were governed by special rules, and a general census of the Empire cannot be put together from them.

The Roman census was both an enumeration of adult male citizens and a tax list. It recorded the name and the age of every independent citizen and all members of his family, although the latter do not appear in the returns, together with the value of his property both real and personal. In the last category slaves were included, but it is not possible to judge from the census the number of slaves. Resident foreigners were not listed, but their property was. The lists were made up upon the sworn statements of the citizens. Returns for widows and orphans were made by their guardians; for emancipated sons by their fathers or grandfathers. The lists so constructed answered all governmental needs, especially taxation and recruiting. For taxation purposes the proletariat (*capite censi*) could be ignored.

The results of even the most careful of these censuses of male citizens are hardly comparable with our modern complete enumerations of whole populations. But the periodical repetition of even a partial enumeration at relatively short intervals over a period of four hundred years, as well as the increasing area covered, gives to the Roman census a significance that no other ancient population record possesses. By the time of Augustus the census covered all Italy, and with the exception of certain troubled times there is no reason to think that it was not reasonably complete so far as the adult male citizens were concerned. The results were not published broadcast. The Romans had no more interest in political arithmetic *per se* than they had in political economy. The census had a wholly practical and material purpose, and was carried no farther than that purpose required. The aim was not to afford later ages a demographic picture of Roman Italy, although the surviving figures enable us to get a rough outline of the growth of the Roman population.

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[1] The matter is too technical and too problematical to be gone into here. It is discussed by Beloch, *op. cit.*, pp. 370–378; H. Nissen, *Italische Landeskunde*, 1902, Vol. II. 1, pp. 112 ff.; E. Kornemann, "Die Censuszählen als statistisches Material," *Jahrbücher für Nationalökonomie und Statistik*, Vol. 69, 1897, pp. 291–296; E. Meyer, "Die Zahl der römischen Bürger unter Augustus," *ibid.*, Vol. 70, 1898, pp. 59–65; Tenney Frank, "Roman Census Statistics," *Classical Philology*, Vol. XIX, 1924, pp. 329–341.

No detailed results have come down to us for any Roman census. In only one or two cases have we anything but the total figure. With the exception of the Augustan census figures, which Augustus had engraved on the Monumentum Ancyranum, even the totals have survived only in the scattered works of the Roman historians, especially Livy.[1]

THE MIDDLE AGES

For a thousand years after the fall of Rome, numerical data on population are practically lacking. The earliest medieval record of any importance is the Domesday Survey made in England at the order of William the Conquerer in 1083–1086. Made to ascertain and record the fiscal rights of the king, this survey can be used as a basis for estimating the population only because of the fact that the names of property owners were recorded. Unfortunately, the most northerly counties, as well as London, Winchester, and some other towns, were omitted. Other than Domesday Book, the only European records, scattering and of later date, are those of surveys of hearths and lists of citizens for certain limited localities. A few registers of hearths in a few villages in Tuscany can be found for a period as early as the thirteenth century, but they are of no importance except as forerunners of the more plentiful data of the same kind available for later times.[2]

From the fifteenth century on we have much more reliable source material than for the earlier Middle Ages. Tax registers and lists of citizens, Bürgerverzeichnisse, become relatively plentiful, and begin to be supplemented, especially in Italy, by genuine, though incomplete, enumerations of population. The first population census of which we have the records seems to have been that of Nürnberg in 1449.[1] Until late modern times a general census of population, or even of hearths, was impossible in Germany because the country was cut up into innumerable petty states. Nevertheless, a proposal for a general enumeration was brought before the Reichstag at Augsburg in 1500 at the behest of the Emperor Maximilian. Nothing came of this.[2]

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[1] The above sketch of the Roman census has been condensed and adapted from Beloch's classical work, *Die Bevölkerung der griechisch-römischen Welt*, 1886, pp. 5–7, 307–311.

[2] Beloch, "Die Bevölkerung Europas im Mittelalter," *Zeitschrift für Socialwissenschaft*, Vol. III, 1900, p. 414.

More scholarship, conjectural and otherwise, has been expended on the history of population in France than in any other European country, yet anything but a problematical estimate of the population of France before 1700 is out of the question. For the whole medieval period there are only two outstanding documents, both providing data as to hearths for limited areas. These documents, the polyptique of the Abbé Irminon, for the ninth century, and the report of 1328 on "Paroisses et feux des bailliages et sénéchaussées de France," raise as many problems as they solve. Neither of them is remotely comparable to a register of citizens or a partial census.[3]

A census of hearths was reputed to have been made in Spain, in 1482, by one Alonso de Quintanilla, at the order of Ferdinand and Isabella. These Catholic Monarchs wished to establish the Santa Hermandad on a national scale, and to this end desired full information as to the taxable capacity of the Kingdom of Castile, to which the census applied. Quintanilla expressly states that he made a count of the hearths or taxpayers in the whole kingdom and that their number was 1,500,000.[4] Quintanilla's word has been accepted by Spanish historians, who put the population of Spain at the end of the fifteenth century at 10,000,000, but the round number for the taxpayers leads Conrad Häbler, who has made the most critical study of Spanish population statistics, to believe that the count was never made and that Quintanilla simply estimated the number of hearths.[5]

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[1] Cf. Karl Bücher, *Die Bevölkerung von Frankfurt am Main im XIV und XV Jahrhundert*, 1886, pp. 9, 10, 31–48; Beloch, "Die Bevölkerung Europas zur Zeit der Renaissance," *Zeitschrift für Socialwissenschaft*, Vol. III, 1900, p. 765.

[2] Beloch, *op. cit.*, p. 777.

[3] On the polyptique of the Abbé Irminon see Levasseur, *La Population Française*, 1889, Vol. I, pp. 125–142; M. F. Lot, "Conjectures démographiques de la France au IXe siècle," *Moyen Age*, Vol. 23, pp. 1–27, 109–137; H. Sée "Peut-on évaluer la population de l'ancienne France?" *Revue d'Economie Politique*, July–Aug., 1924, Vol. 38, pp. 647 ff. On the report of 1328 see Levasseur, *op. cit.*, Vol. 1, pp. 155–170; F. Lot, "L'état des paroisses et des feux de 1328," *Bibliothèque de l'Ecole des Chartes*, Jan.–June, 1929, pp. 51–107, July–Dec., 1929, pp. 256–317.

[4] "Yo he contado muy ciertamente el numero de vecindades de sus reinos de Castilla, é de Leon," etc. Cf. Tomas Gonzalez, *Censo de Población*, Madrid, 1829, p. 94.

[5] Cf. Diego Clemencín, Elógio de la Reina Católica Doña Isabel, *Memorias de la Real Academia de la Historia*, Madrid, 1821, Vol. 6, pp. 601–603; Manuel Colmeiro, *Historia de la Economía Política en España*, 1863, Vol. II, p. 13; Häbler, *Die wirtschaftliche Blüte Spaniens im 16. Jahrhundert und ihr Verfall*, Berlin, 1888, pp. 144 ff.

EARLY MODERN TIMES

A remarkable list of population censuses, some partial, some complete, in Renaissance Italy has been brought to attention by Beloch and Italian scholars. The existence of the records of these censuses in the various Italian archives is probably unknown to many English and American students of population. The brief notice here given to them is taken in the main from the work of Beloch.[1] I have been unable to ascertain that anyone has followed up Beloch's lead in this rich material, although he himself states that in the Neapolitan archives alone there are 1416 volumes of the original enumeration lists of hearths and population, which if copied and analyzed would afford valuable information concerning the population of Italy in the noonday of its prosperity in the sixteenth, seventeenth and eighteenth centuries.[2]

For no region of the earth have we as old or as complete a series of censuses as we have for Sicily. The first of these Sicilian "descrizioni" was made in 1501. Then followed three others in the sixteenth century, six in the seventeenth, and four in the eighteenth. The movement of the Sicilian population can therefore be followed from the end of the Middle Ages to the beginning of the taking of modern censuses. The "descrizioni" gave for each commune the number of hearths, and the number of inhabitants, specified by sex. The male population was further classified into two age groups, 18 to 50 and over 50. However, all these particulars appear only in certain enumerations, those of 1583, 1615, 1642, 1652, 1713, and 1747. The enumerations were made by officials expressly appointed in the various communes.[3]

In the Kingdom of Naples regular enumeration of the population did not begin until 1765, but there were enumerations of hearths from 1465 on. During the Spanish régime only hearths were enumerated, by royal commissions by house to house canvass. While, as in Sicily, the name and age of each person appears to have been taken, no effort was made to summarize the total population, still less to classify it by age and sex.

Statistical data on the population of the Venetian Republic begin about the middle of the sixteenth century, though for the city of Venice and some parts of her territory much earlier material is available.[1] For the city of Venice enumerations of some sort, probably of adult males, are said to have been made as early as the twelfth century, but the results have not been preserved. Reliable data are not available until the early sixteenth century, when figures for men 15–60 years of age are found in the archives for three of the six districts of the city. A church census, the nature of which is not clear, gave the city in 1540 a population of 129,971. In 1552 and 1563 official censuses gave figures of 158,069 and 168,627 respectively, classified into men, women, boys and girls under 16, monks, nuns, beggars, hospitalers, and Jews. There was a similar census in 1581. Other enumerations followed at frequent and fairly regular intervals to 1696, when there is a lapse until 1760. Six enumerations in the eighteenth century are recorded.

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[1] "La popolazione d'Italia nei secoli xvi, xvii, e xviii," *Bulletin de l'Institut International de Statistique*, Vol. III, 1888, pp. 1–42; "Die Bevölkerung Europas zur Zeit der Renaissance," *Zeitschrift für Socialwissenschaft*, Vol. III, 1900, pp. 765–780; "La popolazione della Sicilia sotto il dominion spagnolo," *Rivista Italiana di Sociologia*, Vol. VIII, 1904, pp. 28–45; "Die Volkszahl als Faktor und Gradmesser der historischen Entwicklung," *Historische Zeitschrift*, 3d series, Vol. 15, 1913, pp. 321–337; "Bevölkerungsgeschichte der Republik Venedig," *Jahrbücher für Nationalökonomie und Statistik*, 3d series, Vol. 18, 1899, pp. 1–49. Cf. also Maggiore-Perni, *Popolazione di Sicilia e di Palermo dal X al XVIII secolo*, Palermo, 1892

[2] "La popolazione d'Italia nei secoli xvi, xvii, e xviii," *Bulletin de l'Institut International de Statistique*, Vol. III, 1888, p. 8.

[3] Beloch, "La popolazione della Sicilia sotto il dominio spagnuolo," *Rivista Italiana di Sociologia*, Vol. VIII, 1904, p. 28; "La popolazione d'Italia nei secolo xvi, xvii, e xviii," *loc. cit.*, p. 3.

For the Venetian Republic before 1548 only scattering data survive. In 1548, Stefano Tiepolo, "provveditore generale di Terraferma," ordered an enumeration (descrizione) of all the mainland territory of the Republic. Thereafter there was no general census until 1766, though there were numerous city and district enumerations. Finally, in 1766 a new census was taken of the whole state, and similar enumerations were continued to the end of the Republic. There is no reason, Beloch thinks, to doubt the accuracy of the later censuses, though the earlier enumerations are less reliable. In the latter, entire villages, sometimes entire districts, were omitted, and there were in the records errors in addition and of copying. In the greater part of the cases we are not informed as to the method of enumeration, and in consequence are often uncertain whether a given figure refers to the total population or otherwise, or whether it includes nursing babies, the soldiers, clergy, etc. In some cases, moreover, the figure reported to the government was based not on actual enumeration but on estimate, or a mixture of the two. Despite these difficulties, Beloch holds that it is easily possible to eliminate the major errors, since the data are so copious and means of control not lacking.[2]

For Tuscany, there were enumerations of hearths in the Florentine state in 1559, 1562, 1622, and 1642; in Sienna and its territory in 1612, 1640, 1670, 1677, 1680, and 1691; for the Grand Duchy of Florence, including Sienna, in 1738, 1745, 1751, 1758, 1766, 1791, and 1800; for the Republic of Lucca, in 1733, 1744, 1758, 1781. For Milan, during the Spanish epoch, there was only one enumeration, of hearths, probably in 1542. Later, there were enumerations in 1763, 1778, and 1800.[1]

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[1] Beloch, "Bevölkerungsgeschichte der Republik Venedig." *Jahrbücher für Nationalökonomie und Statistik*, 3d series, Vol. 18, 1899, pp. 1–40.

[2] "La popolazione d'Italia nei secoli xvi, xvii, e xviii," *loc. cit.*, pp. 24, 25; "Bevölkerungsgeschichte der Republik Venedig," *loc. cit.*, *passim*.

It is not surprising, as Beloch says, that in Italy more than elsewhere, from the end of the Middle Ages on, there was a lively sense of the need of statistical data concerning population, since Italy during the Renaissance was culturally the most advanced country of Europe. Nevertheless, the main object of the descrizioni was fiscal, and it was only gradually, and intermittently, that the practise of making enumerations of the whole population became common. The system of censuses of hearths or families remained in force in Naples and Milan to the later days of Spanish rule, but in almost all of the other states of Italy, censuses of population in the true sense of the word had been undertaken by the end of the fifteenth century. In the earlier enumerations it was customary to exclude children under three or five years of age, and also the clergy, or at least the monks and friars. Even in the fifteenth century, however, some states, notably Venice, Tuscany, and Sicily, and from the beginning of the sixteenth century others, began to include children of all ages. In some states the clergy continued to be excluded. In Sicily this was the case still in the eighteenth century. Moreover, since the enumerations were made primarily for fiscal purposes, communes exempt from taxation, which in some cases were large cities, were not included.

In some states, as in Naples and Sicily, the enumerations were executed directly by political authority, but in general the task was assigned to the parish priests, who transmitted their reports to the bishops, who in turn reported to the government. With all its drawbacks, this system was probably the best practicable at the time. The parish priests were not only in position to know the people of their parishes better than anyone else could; they were also less likely to encounter suspicion and opposition than direct agents of the government. Beloch, while perhaps not as sharply critical and exacting as a present-day administrative statistician would be, is convinced from his long study of the documents that the results are in general worthy of confidence.[2] At any rate, the mass of the material, extending over so long a period, and including at so early a time enumerations of whole populations, is sufficient to disprove once for all that Canada, the United States, or some of the American Colonies were the first to take complete censuses of population.

Turning again to Spain, we have for the sixteenth century richer statistical material than for any other country in Europe, with the exception of Italy. There was no reliable enumeration of the whole population of Spain, however, until the establishment of a General Statistical Commission in 1856. The first attempt at a complete enumeration was made in 1802. The censuses of 1768 in Castile and of 1787 and 1797 in Spain at large were evidently based on enumerations of hearths. The so-called censuses of 1482 (if one was actually made in that year), 1530, 1541, and 1594 were enumerations of hearths only—*vecinos* or *vecinos pecheros*, that is, either all heads of families or tax-paying heads of families. These censuses, moreover, were confined to Castile, although there are some data for certain other parts of Spain. Because of this and other differences in the bases of enumeration, the various counts are not comparable with one another without a good deal of critical and to some extent conjectural adjustment. Nevertheless, the statistics of Spain, and especially of Castile, enable us to secure a much more valid conception of the gross movement of population during the sixteenth century than we can possibly have for France, Germany, or England. The importance of the Spanish data, together with the difficulties of their interpretation, are such that they demand fuller and more critical discussion than is possible in a brief sketch.[1]

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[1] "La popolazione d'Italia nei secoli xvi, xvii, e xviii," pp. 10–21, 28 ff.

[2] *Ibid.*, pp. 1, 2, 25.

WESTERN EUROPE IN THE EIGHTEENTH CENTURY

Lively interest in quantitative data on population was evinced during the eighteenth century in France, and also in England. In both countries suggestions for national enumerations began to be made by the middle of the century. The Maréchal de Vauban had proposed an annual census as early as 1707.[2] The time was not ripe, however, and there was no attempt at a general census in France until 1791, when the Constituent Assembly ordered a general enumeration but was unable to bring it about. Through the seventeenth and eighteenth centuries, the government, notwithstanding its fiscal interest in population, especially in evidence during the ministry of Colbert, contented itself with such partial and indirect information as could be secured through the intendents.

At the close of the seventeenth century the intendents were directed to make a full report on the state of affairs in their districts—the number of towns, villages, and hamlets, the number of parishes, and the number of people in each. They were directed also to consult the old registers to see whether the population had formerly been more numerous, and if so, to discover the cause of the decrease. The resulting Mémoires were collected in 1698–1700, and long continued to be the chief basis of population estimates. They were far, however, from constituting a census. Moreover their accuracy left much to be desired. Some gave the number of inhabitants (variously arrived at), some only the number of hearths. Nevertheless, they constitute the only general attempt before 1780 to ascertain the population of France. An analysis of them, by the Duc de Boulainvilliers, was published in 1727–28 under the title, *L'État de la France.*

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[1] On the Spanish data, see, beside the works mentioned above (p. 362 note 5); P. G. Edge, "Pre-census Population Records of Spain," this JOURNAL, Vol. 26, 1931, pp. 416–423. Also in *Metron*, Vol. IX, 1932, pp. 220–240. This article, which consists mainly of an outline of the content of Gonzalez's basic collection, published in 1829, constitutes a good introduction to the material, but fails to give adequate background in the social and economic history of Spain.

[2] *Project d'une Dixme Royale*, 1707, pp. 215, 216.

During the eighteenth century there were a few local enumerations of provinces and parishes, but nothing on which it was safe to base an estimate of the general population.[1] For a time all that was done was to work over the old Mémoires des Intendents. Just before the Revolution there were a dozen or so estimates, revealing the lively interest in the subject.[2] The government during the last twenty years of the Ancient Régime tried seriously to ascertain the size of the population, but this could not be done without a real census.

Active opposition to the proposals for a general enumeration was exerted on religious grounds. Saint-Simon referred to those "dénombrements impies," which had always called down the wrath of God on the people who permitted them to be made.[3] The impracticability of general enumerations was widely reiterated by many authorities.[4] It was admitted that a general census was greatly to be desired, but held that the unrest of the people at the least activity of the government made its execution impossible. The curés were the only persons who might be able to carry it out, but they shared the suspicions of their parishioners, and were utterly ignorant of the social value of a census.

During the Revolution, laws which prescribed the annual ascertainment of the population in each commune remained a dead letter in most départements. The duty was laid on the prefects, but no fixed date of enumeration was set. The Conseil d'État, while recognizing the desirability of a fixed date, considered it impossible to require it. Another attempt at enumeration in 1801 failed, as the results were generally recognized to be extremely defective. The same is true of the census of 1806. The reports of the prefects show that the returns in some prefectures were made up by multiplying the number of hearths by 5. In others the returns for 1806 were constructed by modifying those of 1801 by correction for births and deaths from 1802 to 1806. Some prefects attributed the inexactitude of the returns to the "nonchalence habituelle" of the local officials. From 1806 to 1820 the question of a general enumeration was not raised, partly because of the skepticism of the great mathematician Laplace, but mainly because Napoleon did not want a general count. Laplace's skeptical attitude was due to his knowledge that the proper official regulations had not been provided in 1801 and 1806, and to his belief that they could not be provided. The results of 1821 were made up probably by simple estimate, and the censuses of 1826 and 1831 were apparently not much better. The first reliable French census was that of 1836, though not till 1881 was an enumeration made on the same date in all parts of the country.[1]

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[1] Levasseur, *La Population Française*, 1880, Vol. I, p. 210; A. des Cilleuls, *La population de la France devant 1780;* Morand, *Histoire de l'Académie des Sciences*, 1770, p. 472.

[2] Messance, *Recherches sur la population de Généralités d'Auvergne, de Lyon, de Rouen et de quelques autres Villes du Royaume*, 1760; Necker, *Administration des Finances*, 1784; Calonne, *Population du Royaume*, 1787.

[3] *Mémoires de Saint-Simon*, ed. Chéreul, Vol. VIII, p. 137.

[4] Cf. Brion de la Tour, *Tableau de la Population*, 1780; Necker, *op. cit.*, 1784; de Pommelles, *Tableau de la Population de toutes les Provinces de France*, 1780.

In England the situation was similar to that in France, although England, after it once started, was not so long in securing a reliable census as was France. The more settled political conditions in England may explain this fact. Thanks especially to the pioneering work in "political arithmetick" by John Graunt and William Petty, estimates and conjectures as to the increase or the decrease of the population of England were made frequently during the eighteenth century. In 1753 Thomas Potter introduced a bill in Parliament providing for a general enumeration. The proposal was opposed on the ground that a census would reveal England's weakness to her enemies. Religious prejudice, also, was not lacking. It was held that a census would inevitably be followed by "some public misfortune or epidemical distemper." The proposal was cried down, also, as subversive of the last remains of English liberty. The bill was thrown out by the House of Lords.

The final action of England in taking its first census in 1801 seems to have been due to the arguments of John Rickman. In 1796 he had written a paper entitled "Thoughts on the Utility and Facility of a General Enumeration of the People of the British Empire," which was afterwards published in the *Gentleman's Magazine*. Rickman set forth the economic advantages of ascertaining the number of the people, the probability of the population being much larger than the usual estimates, and the facility with which the population could be deduced from the parish registers. His paper was communicated to Charles

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[1] A. des Cilleuls, "Les recensements de la population en France," *Séances et Travaux de l'Académie des Sciences Morales et Politiques*, Vol. 172, 1909, pp. 782-794; F. Faure, "The development and progress of statistics in France," in John Koren, *History of Statistics*, 1918, p. 287.

[illegible] of the House of Commons. Abbot introduced [illegible] 00, and on its passage offered to Rickman the [illegible]

The decision of Parliament to risk a general enumeration may have been influenced by the fact that the young United States had made a general count of the people, without to any notable degree suffering the displeasure of the Almighty. It is probable, also, that the new trend of population theory introduced by Malthus's Essay in 1798 may have had its influence. Fear that the population was decreasing had now given way to fear of overpopulation and to solicitude over the nation's ability to support an increase in numbers. The preamble of the act providing for the census stated that "in times like these, when subsistence of the people is in question, it is surely important to know the demand for which we are to supply."

The censuses in the Italian states during the sixteenth, seventeenth and eighteenth centuries might well have served as suggestion and models to other countries, had they been known beyond the confines of Italy. The Italian censuses, however, were not taken at regular intervals, nor were those of Canada and the American colonies. The United States census of 1790 was the first one of a regularly recurring series with a decennial interval established by constitutional provision.[2] While there were population censuses in certain continental countries in the first third of the nineteenth century, especially in the German states, hardly any of these countries had established regularly recurrent enumerations before 1861.

The birthplace of continuous vital statistics on a national scale is Sweden, which affords the only uninterrupted series of data which have come down to us from the eighteenth century. In 1746 the mathematician, Pehr Elvius, Secretary of the Swedish Academy of Science, undertook to compile a complete list of births and deaths for the whole kingdom from the parish registers, and to calculate from this the total population. A bill for making tabular records of the Swedish population was approved by the king in 1748. A Tabellenkommission, under the leadership of Wargentin, made careful abstracts of the parish registers from 1749 on. These abstracts were combined every three years (later every five) into so-called censuses. This could be done because, theoretically at least, each parish register would yield each year an accurate account of the parish population—persons registered from previous years, plus new births and persons coming in from other parishes, and less deaths and persons going out to other parishes. In a

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[1] O. Williams, *Life and Letters of John Rickman*, 1912, p. 40.

[2] *Constitution of the United States*, Art. I, sect. 2 (c).

country of limited area and relatively small population, where there is little migration, such a continuous process of demographic bookkeeping was possible, though doubtless it was far from accurate. The procedure of the tabulating commission, which was made permanent by royal rescript of 1756, can hardly be called enumeration.[1]

In the severe condensation of the present survey it has been necessary to omit any treatment of the American colonial and Canadian censuses. Description of the Canadian censuses may be found in Koren and of the colonial censuses in *A Century of Population Growth* (Bureau of the Census, 1909). It is unfortunate, however, that the Census Bureau was not able to publish a fuller account, with more specific documentation.

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[1] League of Nations, *Statistical Handbook Series*, No. 6, *Scandinavian Countries*, 1926, p. 10, Schnapper-Arndt, *Sozialstatistik*, 1908, p. 63. "On the registration systems of Norway, Denmark, and the Netherlands," see Koren, *History of Statistics*, 1918, and League of Nations, *Statistical Handbook Series*, No. 1, 1924.

FERTILITY OF SOCIAL CLASSES IN VARIOUS TYPES OF COMMUNITIES OF THE EAST NORTH CENTRAL STATES IN 1900[1]

By Clyde V. Kiser

This paper is devoted to an analysis of the birth rates of specific social classes in metropolitan, moderately urban, village and rural areas of 1900. Previous studies[2] have indicated that fertility rates are higher in rural than in urban areas and that in both city and country there exists an inverse relation between fertility and social class. In a recent census monograph, Thompson[3] demonstrated an inverse relation between fertility and size of community, but his data could not be analyzed from the point of view of social class. Thus it is impossible to know to what extent the differences he found were simply due to variations in social class composition of the communities, or whether they persist when the fertility of specific social classes within each type of community is considered.

In the official censuses of 1890, 1900 and 1910, the enumerators asked each married woman the number of children she had ever borne. Since the occupations of the husbands were also recorded, these data, though never tabulated by the Census Bureau, are valuable for studies of fertility of women in the various social strata.[4]

Through the courtesy of Professor W. F. Ogburn, Director of Research of the President's Research Committee on Social Trends, the Research Division of the Milbank Memorial Fund was supplied basic data from the 1900 Census pertaining to the fertility of 11,490 married women living in Chicago,[5] 13,800 in five cities ranging from approximately 50,000 to 125,000 population,[6] 10,152 in forty-eight villages[7] of fewer than 5,000 inhabitants, and 6,990 in strictly rural areas of fourteen counties in Ohio, Michigan, Illinois and Indiana.[1]

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[1] From the Division of Research, Milbank Memorial Fund.

[2] See list of studies in Bibliography.

[3] Warren S. Thompson, *Ratio of Children to Women, 1920.* Census Monograph XI, Government Printing Office, Washington, 1931, 242 pp.

[4] With the exception of (f) and (j), all of the studies listed in the Bibliography have been based exclusively upon data tabulated from the original enumeration schedules of the 1910 Census.

[5] In the case of Chicago it was necessary to confine the sample to wards in which a substantial proportion of the wives could qualify with respect to nativity and parentage. Such area-selection was rarely necessary in smaller cities, villages and rural areas.

[6] Columbus, Dayton, Evansville, Grand Rapids and Peoria.

[7] Villages of the 5,000 class by states were as follows: *Indiana*—Auburn, Bluffton, Boonville, Columbia City, Decatur, Franklin, Garrett, Kendallville, Lebanon, Plymouth, Portland, Rochester, Rushville, Tipton and Warsaw; *Illinois*—Anna, Carlinville, Effingham, Flora, Geneseo, Harvard, Hillsboro, Marseilles, Metropolis, Morris and Princeton; *Michigan*—Allegan, Big Rapids, Charlotte City, Coldwater, Greenville, Hastings, Hillsdale and Lapeer; *Ohio*—Barnesville, Bridgeport, Bryan, Celina, Clyde, Eaton, Greenfield, Hillsboro, London, Napoleon, Nelsonville, Pomeroy, Toronto and Wilmington.

Since the chief purpose of this study is to compare the fertility rates of women of specific social classes in communities of varying degrees of urbanization, the data were restricted in order to eliminate the effects of such variables as geographic location, color, nativity, marital status and age composition. Thus the sample was confined to the East North Central states, to native white married women of native parentage who were only once married[2] and were living with husbands of similar parentage at the time of the enumeration. In order to avoid complicated analyses, only women who were still in the child-bearing age when enumerated were considered.

On the basis of the reported occupations of the husbands, the wives included in the non-rural samples were divided into four conventional socio-economic groups, professionals, business class, skilled workers, and unskilled laborers. Rural women could be classified as wives of farm owners, farm renters and farm laborers since such information was obtainable directly from the census schedules.

The division of wives into social classes upon the basis of the occupations of husbands, of course, cannot give entirely satisfactory results. It may be objected that occupation is only one of several criteria of social class, that individuals of widely different character may be found among the representatives of particular occupational groups, that the social class of the husband is not necessarily that of the wife, and that except in a rigidly stratified society, there is a continuous movement of individuals from one social class to another. While the above criticisms are doubtless true, one must admit that such grouping of wives affords four broad classes which, taken as a whole, differ from each other with respect to economic, social and educational attainments.

There are many factors which influence the existing fertility of given social classes, among the more important of which are ages of wives, ages of wives at marriage, economic status, education and other related influences inherent in the interests and style of life characteristic of particular social classes. A few students have attempted by one method or another to examine the relative influence of the separate factors. In this paper, however, the composite rather than the separate effects of such factors are examined for each social class in the several types of communities. Since the age of the wife determines the length of time during which the other factors may operate, however, it is only after age is held constant that one can attribute fertility differences to characteristics inherent in the social classes or in communities themselves.

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[1] Counties from which the rural samples were drawn were as follows, by states: *Illinois*—Bureau, Champaign and Jersey; *Indiana*—Orange, Randolph and Steuben; *Michigan*—Allegan, Gratiot and Lenawee; *Ohio*—Fayette, Highland, Madison, Medina and Wood.

[2] Information concerning the number of times married could not be obtained directly from the 1900 Census schedules. If the duration of marriage exceeded the age of the oldest child, however, it was assumed that neither the husband nor the wife had been married more than once. Obviously such an indirect method could not yield absolutely accurate results. Its inadequacy consisted in the fact that it did not eliminate those cases in which the earlier marriage was childless and those in which all of the children either had died or had left home prior to the 1900 enumeration. It seems reasonable to believe, however, that the number of cases thus erroneously included in the sample is small and that they comprise a group whose earlier marriages were least likely to modify the fertility of existing unions.

In this study fertility is expressed in terms of children ever born per 100 married women. Such a rate is cumulative in that it represents the total past fertility rather than current or annual rates of reproduction. Two statistical devices have been used in controlling the factor of age—the first is that of age-specific rates (cumulative rates for wives in specific age groups) and the second is the total rates standardized for age. The first makes possible the comparison of fertility rates of women of designated age groups. The second affords a means of discovering what rate of fertility would obtain in two or more groups if the same age distribution prevailed among the women.

TABLE I

CHILDREN BORN PER 100 WIVES BY AGE OF WIFE AT THE 1000 CENSUS FOR EACH SOCIAL CLASS AND TYPE OF COMMUNITY

Social class and community	Total under 45	Age of wife at census					
		15–10	20–24	25–20	30–34	35–30	40–44
Professional							
Chicago	141	*	51	03	133	184	212
Moderately urban	155	*	*	08	146	210	245
Village	180	*	*	110	172	251	270
Business							
Chicago	143	*	57	03	140	102	222
Moderately urban	103	*	07	100	170	200	258
Village	184	*	83	130	184	227	207
Skilled workers							
Chicago	163	*	70	124	107	220	242
Moderately urban	106	45	04	154	218	271	323
Village	226	53	107	180	230	318	301
Unskilled laborers							
Chicago	200	*	*	151	105	*	*
Moderately urban	251	62	125	102	262	303	422
Village	263	56	125	214	205	378	425
Rural							
Farm owners	207	*	133	201	285	351	375
Farm renters	262	05	118	108	304	384	447
Farm laborers	221	01	130	207	310	372	*

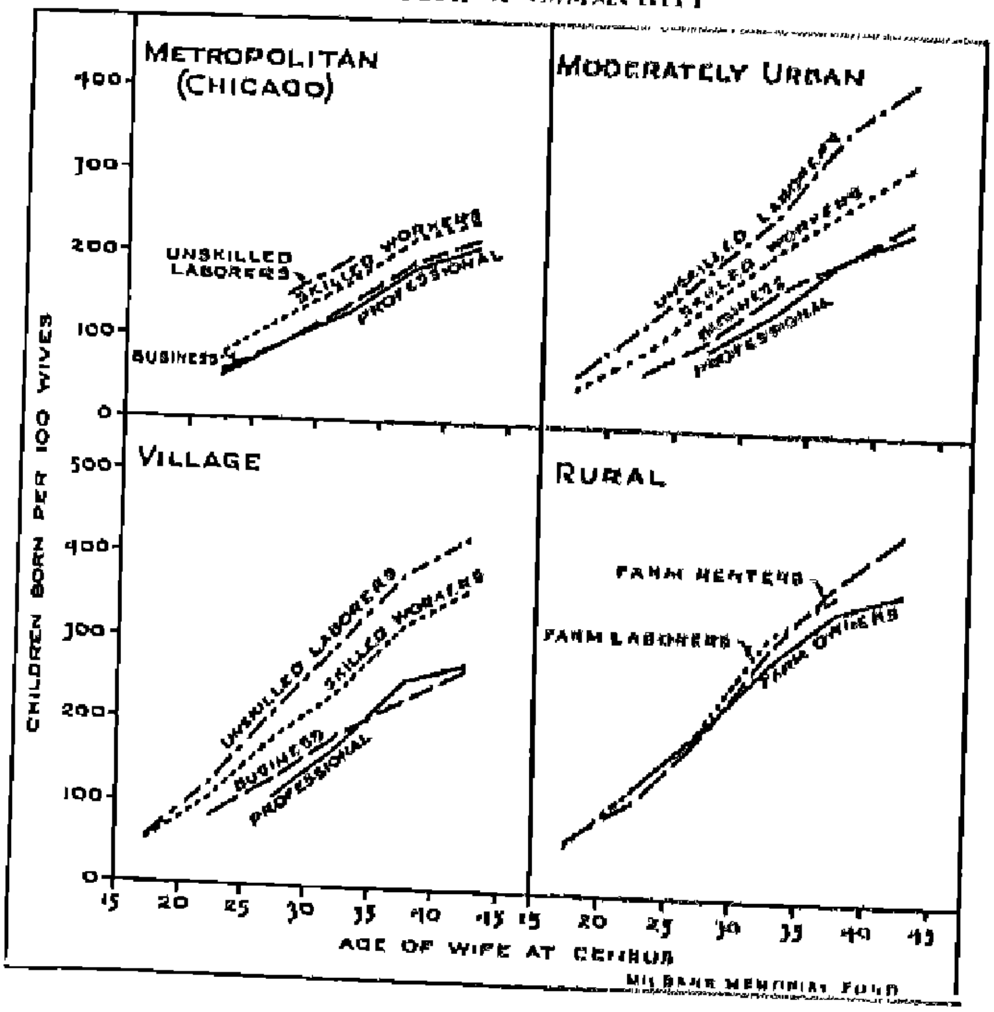
* Rates based on fewer than 100 cases are not shown. For number of cases on which these rates are based, see Table IV.

In Table I the age-specific rates of women in separate social classes are presented for metropolitan (Chicago) moderately urban and village communities. On the basis of these data, Charts I and II were prepared. The former indicates the social class comparisons for each type of community; the latter shows community differences for each social class.

Four facts of some significance are noteworthy: First, in each type of community studied an inverse association between fertility and social status was manifested. Second, with the exception of that of unskilled laborers living in moderately urban communities and in villages, the fertility rate of each non-rural social class was lower than that of the farm owners, the least fertile rural class. Third, for each urban social class, fertility was highest in villages, intermediate in urban centers of 50,000–125,000 population, and lowest in Chicago. Fourth, a striking similarity of all communities appears with respect to the range of difference in fertility of component social classes.

CHART I

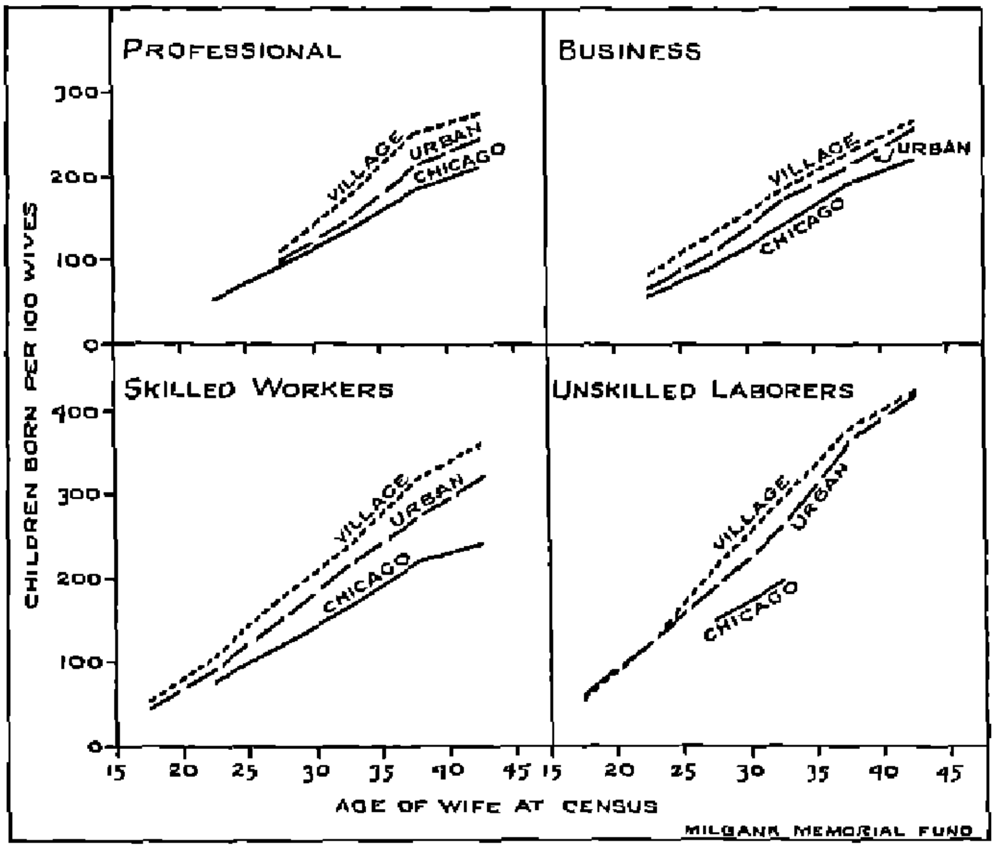
SOCIAL CLASS DIFFERENCES IN FERTILITY BY AGE OF WIFE IN EACH TYPE OF COMMUNITY



It is unnecessary to deal at length with the fact of differential fertility according to social class. Previous analyses of United States census data by the Research Division have demonstrated the manner in which social classes differ in fertility in moderately urban and in strictly rural communities. The data gathered for this paper permitted the extension of such analyses to one metropolitan and to many village communities. In each type of community, unskilled laborers were most fertile, skilled workers were intermediate, and the white-collar workers were least fertile. But whereas there was conspicuous difference between the fertility of unskilled laborers and that of the skilled workers, at practically all ages and in each type of community, the proximity of the rates for the business and professional classes attests the generally undifferentiated nature of the fertility of the white-collar groups in 1900. In the rural population, the age-specific rates indicate that in 1900 differentiation in the fertility of specific classes was not so clearly manifested as among the urban classes.[1] The rates for farm owners 35 years of age and over, however, are probably significantly lower than those for farm renters and farm laborers of the same age groups, and the total rates standardized for age indicate that a differen-

CHART II

DIFFERENCES BETWEEN NON-RURAL COMMUNITIES IN THE FERTILITY OF WIVES OF IDENTICAL AGE AND SOCIAL STATUS



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[1] A study of the trends of fertility of social classes based upon data from East North Central cities of the 50,000–125,000 class revealed that during the interval 1900–1910, the birth rate of the professional class fell definitely below that of the business workers, and that the rural classes became more differentiated. See Bibliography (1).

tiation with respect to fertility of the three rural classes was at least beginning to be shown at that time.

Rural women were conspicuously more fertile than the non-rural. The total rural rate standardized for age was 270 children per 100 wives. Similar rates for non-rural women were as follows: village, 220; moderately urban, 193; and Chicago, 144. Within the rural group itself the total rate standardized for age for farm owners was 262, that for farm renters was 281, and that for farm laborers was 306. The total rate standardized for age for the least fertile rural group, farm owners, surpassed that of the most fertile class in Chicago, unskilled laborers; was practically the same as the rate for such laborers in moderately urban centers; and with the exception of that for unskilled laborers was higher than any rate shown by village social classes. The rate for village unskilled laborers was 278—higher than that for farm owners, almost the same as that for farm renters, but lower than that for farm laborers.

Perhaps more interesting than rural-urban differences are those which appear between the three types of non-rural communities when the birth rates of women of identical social classes are compared. Fertility rates of each urban class were lowest in Chicago, intermediate in smaller cities, and highest in villages. As indicated in Chart II, the differences between communities are small at certain age periods of the wives, but (with one minor exception) throughout all ages and in each social class, the three non-rural communities assume the relative positions described above with respect to fertility.

TABLE II

STANDARDIZED CUMULATIVE BIRTH RATES FOR EACH TYPE OF COMMUNITY AND FOR COMPONENT SOCIAL CLASSES*

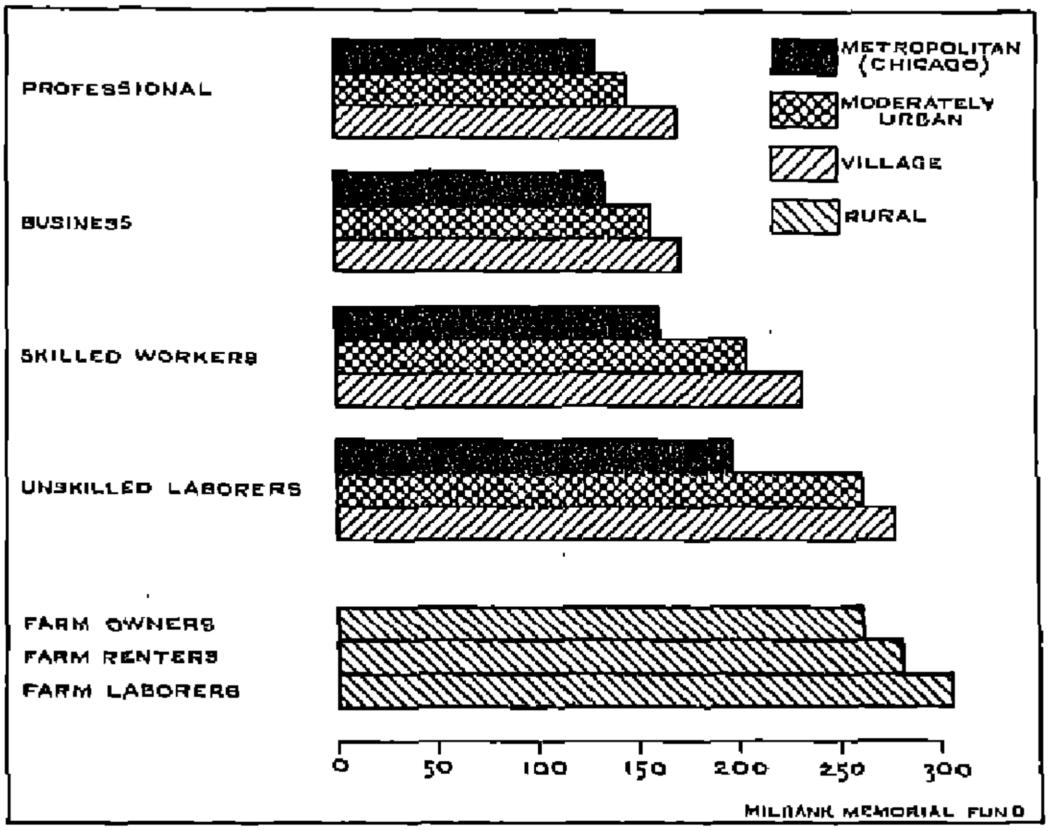
Community	Total	Professional	Business	Skilled workers	Unskilled laborers	Farm owners	Farm renters	Farm laborers
Chicago	144	130	135	162	198	...	...	...
Moderately urban	193	146	157	205	263	...	...	...
Village	220	171	172	233	278	...	...	...
Rural	270	...	...	...	...	262	281	306

* The standard adopted is the same as that used in previous analyses of 1910 data, i.e., the age distribution of the total sample secured from the 1910 Census schedules. See (a), Bibliography.

Total rates standardized for age for each social class and for each type of community facilitate summary comparisons, Table II, Chart III. The fertility of the professional class in Chicago was surpassed 12.3 per cent by professionals in smaller cities and 31.5 per cent by women of the same social class in villages. The birth rate of the business class was 16.3 per cent higher in urban districts and 27.4 per cent higher in village communities than in Chicago. As for skilled workers, rates were 26.5 per cent higher in urban communities than in Chicago and skilled workers residing in villages were 43.8 per cent more fertile than similar craftsmen of the metropolis. The fertility of the unskilled laborers of Chicago was surpassed 32.8 per cent and 40.4 per cent by representatives of the same occupational status in the urban and village communities respectively. Thus, birth rates for specific social classes, as well as those for total communities, fall with increasing urbanization.

CHART III

CUMULATIVE BIRTH RATES STANDARDIZED FOR AGE FOR WOMEN OF IDENTICAL SOCIAL CLASSES BUT RESIDENT IN VARIOUS TYPES OF COMMUNITIES



Another comparison of fertility rates which holds constant the factors of age and social class composition is afforded by standardization for age and social class. Such comparison is one which would exist if each community had the same age and social class distribution. In standardizing for social class the total rates standardized for age for each social class were weighted by the proportions by which the specific social classes were represented in the total non-rural sample. Thus single indices were obtained for each type of community, just as the total rates standardized for age are summary figures derived from age-specific rates in each social class. After both age and social class composition were held constant, the Chicago fertility rate was 154, the moderately urban rate was 189, and the village rate was 210. Under such conditions the moderately urban rate, based upon the samples studied, was 22.7 per cent higher than that of Chicago, and the village rate surpassed that of the metropolis by 36.4 per cent.

While the fertility rates of each social class were lowest in Chicago, intermediate in cities of moderate size, and highest in villages, the difference between social classes was strikingly similar in each of the three types of communities. Not only was the order of the classes the same with respect to fertility in each type of community but the spread of the rates was not greatly different. This similarity in the spread of the rates is not readily apparent from Chart I because of the absence of rates for age groups in which the number of cases was small. It is better shown by the percentages which the standardized rate for each social class forms of that for all classes combined in the same type of community. The latter rate was standardized both for age and social class in order to eliminate biases arising from the greater weight of certain classes in one community than in another.

The rates for the least fertile social class, professional, were 84 per cent, 77 per cent, and 81 per cent of the total community rates in Chicago, moderately urban centers and villages, respectively. The rates for the most fertile class, unskilled laborer, were 129 per cent, 139 per cent and 132 per cent of the respective community rates standardized for age and social class. See Table III, Chart IV.

TABLE III

PER CENT WHICH THE STANDARDIZED BIRTH RATE OF EACH SOCIAL CLASS FORMS OF THE TOTAL RATE FOR ALL CLASSES COMBINED. EACH TYPE OF COMMUNITY *

Rate standardized for age and social class	Chicago		Moderately urban		Village	
	154		189		210	
	Rate	Per cent	Rate	Per cent	Rate	Per cent
Professional	130	84	146	77	171	81
Business	136	88	157	83	172	82
Skilled workers	162	105	205	108	233	111
Unskilled laborers	198	129	263	139	278	132

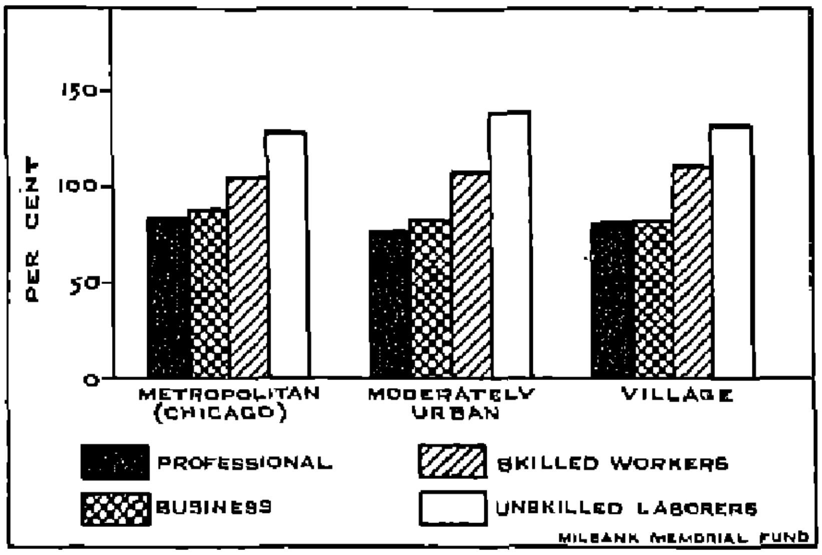
* Rates for all classes combined were standardized for both age and social class.

Since a previous study of the 1900 fertility rates in the moderately urban and strictly rural communities represented in the present study had revealed a more pronounced differentiation of the social classes with respect to fertility in cities of 50,000 to 125,000 population than in strictly rural communities, it seemed possible that the results of the present investigation might reveal an increasing degree of divergence of fertility rates between social classes as one passes from village to urban, and from urban to metropolitan communities. On the contrary, however, a striking similarity appears and the small differences that do exist indicate slightly greater spread in the moderately urban communities than in either Chicago or in villages.

CHART IV

SIMILARITY OF THE ORDER AND SPREAD OF BIRTH RATES FOR THE SOCIAL CLASSES IN DIFFERENT TYPES OF COMMUNITIES

The standardized rate for each class is shown as a per cent of that for all classes combined in the same communities. In rates for all classes each social class was given the same weight in all communities shown. See Table III.



While an interpretation of this small difference can be no more than suggestive, there is the interesting possibility that in moderately urban centers the urban influences conducive to low birth rates had a greater effect upon the white-collar classes than on the laboring classes than was the case in villages where neither class was greatly affected by urban mores and in Chicago where the stringent conditions of urban life affected the lower classes as well as the white-collar workers. Whatever the explanation may be, the striking fact of this comparison is that in 1900 there was little difference between the relative spread of the birth rates of the social classes in villages with about 5,000 population, and Chicago with over one and one-half millions.

It is necessary to remember certain characteristics of the data before formulating personal conclusions. First, the data refer simply to the reproductivity of native white married women in unbroken families.

The rates cannot be interpreted as indices of the actual extent to which women in the various social classes were reproducing within the several communities. If foreign born were included in the sample, for instance, one would expect the present rates for unskilled laborers to be more affected in Chicago than in moderately urban and village communities. Also, by virtue of the fact that the rates are simply for married women they do not take into account differences in the proportion of potential mothers who are married. The problem at hand, however, was to examine the differences in fertility which seem to accrue from characteristics inherent in the types of communities themselves and for that reason, variables such as race, nativity, age and marital status were held constant.

TABLE IV

NUMBER OF WIVES CONSIDERED BY AGE AT THE 1900 ENUMERATION FOR EACH SOCIAL CLASS AND FOR EACH TYPE OF COMMUNITY

Social class and community	Total under 45	Age of wife at census					
		15–19	20–24	25–29	30–34	35–39	40–44
Professional							
Chicago	1,492	6	123	353	406	356	248
Moderately urban	873	6	96	210	213	201	147
Village	855	8	88	169	215	209	165
Business							
Chicago	6,607	64	810	1,492	1,634	1,438	1,160
Moderately urban	4,609	68	649	1,055	1,089	945	803
Village	2,911	56	539	636	642	523	513
Skilled workers							
Chicago	2,612	49	443	602	639	440	460
Moderately urban	6,136	191	1,279	1,518	1,277	1,041	870
Village	3,650	161	673	851	742	649	583
Unskilled laborers							
Chicago	489	12	83	108	110	89	87
Moderately urban	2,182	115	419	501	418	408	320
Village	2,727	167	545	612	540	458	415
Rural							
Farm owners	3,068	41	261	492	677	745	850
Farm renters	2,787	108	608	687	605	461	316
Farm laborers	1,138	139	369	276	160	121	73

In the second place, the data refer to female residents of given communities at the time of the 1900 enumeration. An unknown proportion of the wives included in each type of urban community considered migrated from the rural districts after all or part of their children were born or at least after a period of long residence in an environment where rural culture prevails. In a strict comparison of differences in fertility of women in communities of varying size of population, it would be desirable to choose for study only those wives who were indigenous residents of the communities in which they were found at the time of the enumeration or were migrants from communities of similar types. In regard to the migration, it is also necessary to bear in mind the fact there are selective as well as determinative factors which help to account for differences observed between social classes and communities. In respect to fertility, these factors are so intricately interwoven that it is practically impossible to separate them. The lower rates of fertility of wives in Chicago were doubtless due in some measure to the lack of attractiveness of a metropolis for large families migrating from rural areas. Such families encounter greater difficulties in a metropolis than in smaller cities and villages in obtaining satisfactory and economical living arrangements. A further interpretation necessitates further knowledge of the selective factors involved in the process of migration from rural areas to urban centers of varying size.

In the third place, while the data indicate an inverse association between fertility and size of community, no claim is made that size of population *per se* is the responsible factor for the differences in birth rates observed. The cities have not been studied separately, nor have they been thrown into categories of *gradually* increasing size.[1] The four types of communities studied are so widely different in size that the mode of life in one is commonly regarded as being much different from that characteristic of another.

In summary, the data indicate that in each type of community studied there was an inverse relation between fertility and social status. Rural wives were most fertile, village wives stood second, residents of moderately urban centers were third, and Chicago wives were least fertile. The inverse association between fertility and social status holds true when women of identical social status in the three types of non-rural communities are considered separately. Although the rates for all urban social classes were highest in villages, intermediate in moderately urban centers, and lowest in Chicago, there was striking similarity in the order and spread of the rates for component classes in each type of community.

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(a) Edgar Sydenstricker and Frank W. Notestein: "Differential Fertility According to Social Class," this JOURNAL, March, 1930, xxv, New Series, No. 169.

(b) Frank W. Notestein: "Social Classes and the Birthrate," *Survey Graphic*, April, 1931.

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[1] In order to ascertain whether or not fertility is associated with differences of population within a group of moderately urban centers, birth rates (births per 100 wives, standardized for age) for two social classes were computed for eight separate cities of the East North Central states. The data were obtained from the original enumeration sheets of the 1910 Census. The four largest cities had more than 200,000 population and the four smallest fewer than that number. In the four largest cities the range of the rates for either social class was practically the same as that which existed in the four smallest cities. The results, therefore, seemed to indicate that among communities of *approximately* the same degree of urbanization, size of population is not of first consequence. See Bibliography (j).

(c) Frank W. Notestein: "Differential Age at Marriage According to Social Class," *The American Journal of Sociology*, July, 1931, xxxvii, No. 1.

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THE DISPLACEMENT OF WORKERS THROUGH INCREASES IN EFFICIENCY AND THEIR ABSORPTION BY INDUSTRY, 1920-1931

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The status of employment and unemployment statistics in the United States is such that figures on the current volume of employment or unemployment are necessarily based either on reasonable guesses or rather vague estimates. If this is true of such cover-all data as "total unemployment," how much more true must it be of data relating to such subdivisions as "technological unemployment," or to figures giving the extent of fluctuations in employment due to one or another of the many forces which bring about such fluctuations. In point of fact, a true measurement of the extent of unemployment in the United States would necessitate a daily or weekly enumeration of the unemployed. Short of such censuses this could be accomplished only by means of a national system of employment exchanges. Such exchanges, armed either with authority to compel every unemployed worker to register, or powerful incentives such as reasonable assurance of a job or unemployment insurance, could, by means of proper clerical and statistical devices, measure not only the extent of unemployment, but also the various factors contributing to fluctuations in employment. Any such system seems still to be in the distant future as far as the United States is concerned. And yet, the demand for this type of information is becoming ever greater with the growing interest in all kinds of labor legislation, especially insurance against unemployment.

The analysis described in this paper was undertaken in an attempt to devise a statistical procedure which would afford an approximate measure of two of the more important types of employment fluctuations: those due principally to changes in the physical volume of output, and those which can be ascribed chiefly to changes in technological and managerial efficiency.

Existing indexes of employment reflect neither the full extent of fluctuations in employment nor the interplay of the forces which cause these fluctuations. The first deficiency is due in a large measure to the fact that the employment indexes are based upon numbers reported on the payrolls—which numbers include part-time employees as well as full-time employees. The second deficiency is due simply to the lack of direct information. These employment indexes, therefore, had to be abandoned in this study and new indexes constructed. Again, in order to derive the degree of displacement due to changes in the output per man-hour it was necessary to construct a measure of the output per man per hour. This, in turn, necessitated the use of some index of physical production and the construction of an index of man-hours worked. In the analysis of these factors this study confines itself to Manufacturing Industries, Class I Railroads, Bituminous Coal Mining and Anthracite Coal Mining.

It is fully realized that the results obtained are subject to the deficiencies inherent in the data which were used in the computations, and yet, it seems desirable to submit these results as something which tends to indicate the *direction* of the movement of important factors in employment even if the full extent of these movements cannot be said to have been measured satisfactorily.

Manufacturing Industries.—The material used was obtained from two separate and independent sources: the Federal Reserve Board and the National Industrial Conference Board. The Federal Reserve Board publishes indexes of factory payrolls and indexes of physical production in manufacturing industries, while the "Index of Average Hourly Earnings in 24 Manufacturing Industries" and the "Index of Average Full-Time Hours Per Week" were obtained from publications of the National Industrial Conference Board.

The Federal Reserve Board index of physical production was computed by the use of the so-called "aggregate method" and is based upon primary data of considerable variety, all of which provide current indications of the volume of production of principal industries, expressed in physical quantity units. The industries thus directly or indirectly represented include about 80 per cent of the value added by all manufacturing industries in 1923. "Some of the more important manufacturing industries not included in the index are canning, butter and cheese, certain chemicals and drugs, railroad repair shops, and musical instruments. Others which are only indirectly represented by subsidiary industries are machinery and equipment, clothing, furniture, and printing and publishing of books and magazines."[1]

The Federal Reserve Bulletin index for factory payrolls is based in "largest part" on statistics of payrolls that become available monthly and which now embrace 50 industries accounting for about 80 per cent of total factory payrolls in the United States.[2] This index is revised from time to time by the use of the statistics from the biennial Census of Manufactures. The last revision is based on the Census of 1927. The current fluctuations are, therefore, "determined altogether by the statistics reported by manufacturing establishments every month, while the general level of the index in 1928 and 1929 is determined in part by an allowance based on the Census of 1927 for industries that do not report currently."[1]

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[1] *Federal Reserve Bulletin*, March, 1927, p. 170.

[2] *Federal Reserve Bulletin*, November, 1929, pp. 707–708. The industries which are included currently but not prior to 1923 are: petroleum refining, shipbuilding, manufacture of fertilizers, rubber boots and shoes, and automobile tires.

The National Industrial Conference Board indexes of hourly earnings and full-time hours are based upon approximately 9 per cent of the total number of wage earners in manufacturing industries.[2] In spite of the smallness of the sample, these indexes were used in this study rather than the available data published by the United States Bureau of Labor Statistics. The reasons for this preference are the following. Though the absolute figures of the National Industrial Conference Board are open to objections it was, nevertheless, felt that the *relative* movement of these figures mirrors fairly faithfully the true movement of the correct actual figures—whatever these may be. Furthermore, the annual averages of the National Industrial Conference Board are based upon monthly returns and consequently can be expected to be more sensitive than the Bureau of Labor Statistics material which often is representative of no more than a single month during any one year. The following tabulation affords a comparison between the two series of hourly earnings:

	Link Relatives of	
	Bureau of Labor Statistics index of hourly earnings in industries other than agriculture	National Industrial Conference Board, hourly earnings in 24 manufacturing industries
1920	100	100
1921	93	87
1922	95	94
1923	104	109
1924	103	104
1925	101	100
1926	101	101
1927	101	101
1928	100	100
1929	101 *	102

Source: The Bureau of Labor Statistics series was computed on the basis of index numbers in the *Monthly Labor Review*, February, 1931, p. 143, while the National Industrial Conference Board series was computed on the basis of actual data published in *Wages in the United States, 1914–1930*, p. 47.
* Preliminary.

It will be noticed that, especially subsequent to 1923, there is very little difference between the relative fluctuations of the two series. Finally, the National Industrial Conference Board series is the only readily available series on hourly earnings which presents homogeneous data in a comparable form throughout the entire period under consideration.

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[1] *Federal Reserve Bulletin*, November, 1929, p. 708.

[2] National Industrial Conference Board, *Wages in the United States 1914–1930*, p. 10.

The data described above were used as in Table I.

TABLE I
MANUFACTURING INDUSTRIES—PAYROLLS, PRODUCTION AND LABOR COST, 1920–1931
(1920=100)

(1) Year	(2) Index of payrolls*	(3) Index of physical volume of production**	(4) Index of labor cost per unit $\frac{(2)}{(3)}\times 100$	(5) Index of hourly earnings, 24 manufacturing industries §	(6) Index of full time hours per week, 24 manufacturing industries §	(7) Index of full-time weekly earnings $\frac{(5)\times(6)}{100}$
1920	100	100	100	100.0	100.0	100.0
1921	65	77	84	88.5	99.4	88.0
1922	69	100	69	81.5	100.0	81.5
1923	87	118	74	89.1	100.0	89.1
1924	81	110	74	92.6	99.2	91.9
1925	86	124	69	92.4	100.0	92.4
1926	88	127	69	93.6	99.6	93.2
1927	86	124	69	94.9	99.2	94.1
1928	86	131	66	95.4	99.4	94.8
1929	92	140	66	97.0	99.4	96.4
1930	74	112	66	97.0	97.6	94.7
1931	56	95	59	93.0	96.2	89.5

Sources:

* Federal Reserve Board.

** 1920–1922, converted to 1920 base from data in *Recent Economic Changes*, National Bureau of Economic Research, Table 10, p. 449; 1923–1929, this JOURNAL, December, 1930, p. 457, Table 2; "Volume of Production in Manufactures."

† Preliminary.

‡ Federal Reserve Board Index of production, corrected on the assumption that the error involved in the Federal Reserve Board index of 1930 and 1931 is the same as that involved in the preceding five years as revised in the JOURNAL article (see footnote **).

§ National Industrial Conference Board.

First, the Index of Factory Payrolls was divided by the Index of Physical Volume of Production. The result, multiplied by 100, yielded an Index of Labor Cost per unit of output. Then the Index of Hourly Earnings was divided by the Index of Labor Cost in order to obtain the output per man-hour.[1] (See Table II, column 2.)

The operation, $\frac{1}{\text{Output per Man-Hour}}\times 10{,}000$, is, therefore, equivalent to "the number of men needed to produce the physical output of 100 men in the base year of the index."[2] This number does not, however, take the fluctuations in full-time hours during the period into consideration. Since the work-hours in the standard work-week tended to decline during the years 1920–1931, a certain number of workers who would have been displaced by increases in efficiency were able to retain their jobs. The magnitude of this effect was determined in the following manner. By multiplying the hourly earnings by the number of full-time hours per week, the full-time weekly earnings were obtained (Table I, column 7). These weekly earnings, when divided by the labor cost per unit of output, yielded the output per man-week; the reciprocal of this last figure was, therefore, the equivalent of the number of man-weeks needed to produce the physical output of 100 man-weeks in 1920.[1] Since all of the operations described above were carried out by means of relatives, the index numbers appearing in Table II, column 3, are applicable to full-time man-years as well and were used as such. The differences between the data in Table II, column 3, and 100.0 are, therefore, the per cent changes in employment brought about as the immediate result of changes in technological and managerial efficiency (Table II, column 4).

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[1] The reasonableness of this operation becomes clear, when a concrete example is considered. Assume the labor cost of a single unit to be $2.00, and the average hourly earnings of a worker engaged in the manufacture of that product, 50 cents. The 50 cents are, therefore, equal to the labor cost of ¼ of a unit, or ¼ of a unit is produced during one hour of work.

[2] For, if one man produced ¼ of a unit during one hour of work in 1920, and ½ a unit during one hour of work in 1930, then only ½ the number of workers are needed in order to produce the same number of units of output. Or, if the productivity in 1920 (¼ of unit) is called 100 per cent, the productivity in 1930 (½ unit) becomes 200 per cent and the number of men needed in 1930 to produce the physical output of one man in 1920 is equal to 100 per cent ÷ 200 per cent, or ½. Since relatives are employed throughout the calculations and since, furthermore, the changes are measured from the base year as 100.0, the computations are facilitated by computing the reciprocal of the index of output per man-hour in any one year and multiplying it by 10,000.

TABLE II

MANUFACTURING INDUSTRIES—PER CENT CHANGE IN EMPLOYMENT, BY TYPE, 1920–1931

(1920 = 100)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Year	Index of output per man-hour	Number of men needed to produce the output of 100 men in base year (1920)	Per cent changes in employment since 1920			Index of employment
			Due to changes in output per man-hour *	Due to changes in volume of physical output	Total net change	
1920	100.0	100.0	0.0	0.0	0.0	100.0
1921	102.5	98.2	− 1.8	−22.6	−24.4	75.6
1922	118.1	84.7	−15.3	0.0	−15.3	84.7
1923	120.8	82.7	−17.3	+14.9	− 2.4	97.6
1924	125.8	80.1	−19.9	+ 8.0	−11.9	88.1
1925	133.2	75.1	−24.9	+18.0	− 6.9	93.1
1926	135.1	74.3	−25.7	+20.1	− 5.6	94.4
1927	136.8	73.7	−26.3	+17.7	− 8.6	91.4
1928	145.3	69.2	−30.8	+21.5	− 9.3	90.7
1929	147.6	68.2	−31.8	+27.2	− 4.6	95.4
1930	146.8	69.8	−30.2	+ 8.3	−21.9	78.1
1931	150.4	65.2	−34.8	− 2.6	−37.4	62.6

* These changes in employment are not due *solely* to changes in output per man-hour. They include also the increases in employment opportunities resulting from the decline of the full-time hours of work per week. Since the full-time hours changed only slightly from 1920 to 1929, the effect on employment was negligible.

It is fully realized that changes in the output per man-hour and the accompanying changes in the volume of employment may be brought about by a multitude of factors. Among such factors may be: the relative strength of trade-unionism, changes in wage-policy, changes in the hours of work, managerial improvements, technological improvements, changes in the labor-personnel, fluctuations in the price-level, general business conditions, the flow of work, etc. Again, the change in the output per man-hour may, and no doubt does, itself, produce conditions which may in turn result in further changes in the general complex of factors affecting the volume of employment and the character of the fluctuations. This article does not, however, concern itself with the remote causal relationships among the various factors. It regards as within its purview only the quantitative aspects of the various types of fluctuations in employment, and bases its analysis upon the existing relationship between the physical volume of output, the physical volume of output per man-hour, and the total number of man-hours worked, namely:

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[1] See footnotes 1 and 2 on page 380.

$$\frac{\text{Output}}{\text{Man-Hours}} = \text{Output per Man-Hour.}$$

The output per man-hour having increased steadily during the years 1920–1931, except in 1930, these fluctuations in employment, due to changes in technological and managerial efficiency, were negative in every single year during the period, and, in 1931, reached a point where approximately 35 men out of every 100 men employed in 1920 had been displaced by the various devices which made for an increase in the physical output per man-hour.

Some of these displaced men, the great majority as will be seen later, were, however, reabsorbed by the increased employment necessitated by the growing physical volume of output during the period 1920–1929. During cyclical recessions, on the other hand, a certain number of workers were added to those "technologically" displaced by drops in employment caused by violent declines in the volume of physical output. In order to determine the extent of these cyclical influences on the volume of employment, Table II, column 3, was multiplied by the index of physical production (Table I, column 3). The result obtained, when divided by 100, yielded an index of employment in terms of equivalents to full-time employment, thus excluding any inflations or deflations due to part-time work or over-time. This last index (Table II, column 7) when subtracted from 100 gave the per cent changes in employment since 1920 (Table II, column 6). It was then inferred that the difference between the "total net change" in employment (Table II, column 6) and the fluctuations due to changes in the output per man-hour (Table II, column 4) was due to the changes in the volume of physical output. These per cent changes in employment, caused by the cyclical variations in the physical volume of production, are given in Table II, column 5.[1]

An inspection of the data in Table II reveals a number of significant points.

First, a chart of the index of employment obtained by the method described in this paper, plotted together with the index of factory employment published by the Federal Reserve Board, would show that both indexes move in the same manner, except that the Federal Reserve Board index fluctuates less violently. This is precisely as would be expected since the Federal Reserve Board index is based upon monthly reports of numbers of men on the payrolls, thus including partial as well as full-time employment, while the derived index is given in terms of full-time equivalents and is, therefore, more sensitive to the changes in the physical volume of production. It should also be noted that the discrepancies between the two employment indexes are widest during the depression years 1921, 1924, 1927, 1930 and 1931. This fact tends to support the explanation that the difference is due to the presence of a cushion in the labor forces included in the Federal Reserve Board index which tends to absorb the effect of over-time and to minimize the fluctuations due to partial employment. As a consequence, the derived index dips deeper in times of depression and rises higher during periods of active business. The following tabulation gives the two employment indexes together with the differences between them.

Second, the index of output per man-hour (Table II, column 2) indicates clearly the pressure which is exerted upon the productive apparatus to bring about greater efficiency during periods of business

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[1] One of the principal difficulties inherent in the statistical procedure used in this paper is the fact that the original data underlying the entire analysis are in the form of index numbers. In order to avoid unnecessary multiplication of the errors contained in the basic data, errors, moreover, the precise magnitudes of which are unknown, the attempt was made to reduce the arithmetical operations to the smallest possible number and to avoid operations with index numbers which *derived* from the basic data. As a consequence, the actual computations were performed not in the manner indicated in the text, but in accordance with the formulae given below.

$$\text{(A) Labor Cost per Unit} = \frac{\text{Payrolls}}{\text{Physical Volume of Production}}$$

$$\text{(B Output per Man-Hour} = \frac{\text{Hourly Earnings}}{\text{(A)}} = \frac{\text{Hourly Earnings} \times \text{Production}}{\text{Payrolls}}$$

$$\text{(C)} \left.\begin{array}{l}\text{Number of Men in} \\ \text{any Year needed to} \\ \text{produce the Output} \\ \text{of 100 Men in the} \\ \text{Base Year}\end{array}\right\} = \frac{\dfrac{1}{\text{Full-Time Weekly Earnings}}}{\text{(A)}} = \frac{\text{Payrolls}}{\text{Production} \times \text{Full-Time Weekly Earnings}}$$

$$\text{(D) Employment} = \text{(C)} \times \text{Production} = \frac{\text{Payrolls}}{\text{Full-Time Weekly Earnings}}$$

(E) Total Net Change in Employment = 100 — (D)

(F) Change in Employment due to Change in Output per Man-Hour = 100 — (C)

(G) Change in Employment due to Change in Physical Volume of Production = (E) — (F)

Year	Indexes of employment in manufacturing industries 1920 = 100		Derived index minus Federal Reserve Board index (points)
	Federal Reserve Board	Derived index	
1920	100.0	100.0	0.0
1921	75.9	75.6	-0.3
1922	83.3	84.7	+1.4
1923	96.3	97.6	+1.3
1924	88.9	88.1	-0.8
1925	92.6	93.1	+0.5
1926	93.5	94.4	+0.9
1927	91.7	91.4	-0.3
1928	89.8	90.7	+0.9
1929	93.5	95.4	+1.9
1930	81.5	78.1	-3.4
1931	68.5	62.6	-5.9

depression and the intensified competitive conditions that go with it. The tabulation below gives the year to year per cent changes in the output per man-hour in manufacturing industries.

It may be observed that the average annual increase in output per man-hour was about 4.4 per cent and that every depression year, 1921, 1924, 1927, and 1930, was followed by a more than average rise in the rate of increase, while every peak year during the period, 1923, 1926, and 1929 was a year of a relatively low rise in efficiency. The year 1930 not only failed to show an increase in the output per man-hour, but actually registered a decline. The explanation for this may well be sought in the widespread efforts, sponsored by high governmental officials, public bodies and individual employers, to maintain a larger number of employees on the payrolls than was warranted by the physical volume of output, by means of the so-called "stagger plan" and other devices calculated to increase part-time employment.

The third item of significance is the relationship between the employment index and the index of physical production. Link relatives

Year	Year to year changes in output per man-hour
	Per cent
1920	0.0
1921	+ 2.5
1922	+15.2
1923	+ 2.3
1924	+ 4.1
1925	+ 5.9
1926	+ 1.4
1927	+ 1.3
1928	+ 6.2
1929	+ 1.6
1930	− 0.5
1931	+ 8.6
Average	+ 4.4

of these indexes reveal that increases in the volume of production are accompanied by less than proportionate increases in employment, while a decline in the volume of production is followed by a more than proportionate drop in employment. The reason for this difference in the type of fluctuation becomes clear when it is observed that the index of output per man-hour is steadily rising: a rise in the volume of output consequently requires a less than proportionate increase in the volume of employment; conversely, a decline in the volume of output results in a more than proportionate shrinkage in the number employed. It follows, therefore, that in order to retain or increase the total volume of employment, improvements in the efficiency of industrial processes must be accompanied by a rate of growth in the physical volume of output, which is equal to or greater than the rate of increase in efficiency. It follows furthermore that, given a country with an increasing number seeking gainful employment and a progressive technology, the rate of growth of the physical volume of production must not only be greater than the rate of growth of efficiency, but it must be sufficiently more rapid to create an additional demand for employment large enough to absorb the new additions to the labor supply. The absence of the above conditions is bound to result in a constantly growing "labor reserve."[1]

(1)	(2)	(3)
Year	Link relatives of index of production	Link relatives of index of employment
1920	100.0	100.0
1921	77.0	75.6
1922	120.9	112.0
1923	118.0	115.2
1924	93.2	99.3
1925	112.7	105.7
1926	102.4	101.4
1927	97.6	99.8
1928	105.6	99.2
1929	106.9	105.2
1930	80.0	81.9
1931	85.7	70.0

Fourth, the general tendency in the physical volume of output during the period 1922–1929 seems to have been such as to absorb the great majority of the workers displaced as a result of increased productivity. In 1929, for example, out of about 32 men in every 100 who had been displaced since 1920, about 27 had been absorbed by the increased volume of output. The remaining 5 may or may not have found employment in industries other than manufacture.

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[1] This generalization does not take into consideration the possible equalization between the various factors, by means of such expedients as the shortening of the working day or the working week. Nor has an attempt been made to establish whether the conditions cited above had obtained in the past. In order to determine these relationships a host of additional data would have to be collated—a task which lies beyond the scope of this paper.

The above analysis is based upon the year 1920. Since that year was one of extremely high employment, it was thought advisable to measure the changes in employment from other vantage points. What were the movements from year to year? What were they from one cycle to another?

To accomplish the first objective, link relatives were constructed of column 3, Table II, and column 7, Table II. The results appear in Table III.

TABLE III

MANUFACTURING INDUSTRIES—YEAR TO YEAR PER CENT CHANGES IN EMPLOYMENT, BY TYPE, 1920–1931

(1)	(2)	(3)	(4)	(5)	(6)
Year	Link relatives of Table II, col. 7	Link relatives of Table II, col. 3	Per cent changes in employment measured from preceding year		
			Due to changes in the output per man-hour *	Due to changes in volume of physical output	Total net change
1920	100.0	100.0	0.0	0.0	0.0
1921	75.6	98.2	− 1.8	−22.6	−24.4
1922	112.0	86.3	−13.7	+25.7	+12.0
1923	115.2	97.6	− 2.4	+17.6	+15.2
1924	90.3	96.9	− 3.1	− 6.6	− 9.7
1925	105.7	93.8	− 6.2	+11.9	+ 5.7
1926	101.4	98.9	− 1.1	+ 2.5	+ 1.4
1927	96.8	99.2	− 0.8	− 2.4	− 3.2
1928	99.2	93.9	− 6.1	+ 5.3	− 0.8
1929	105.2	98.6	− 1.4	+ 6.6	+ 5.2
1930	81.9	102.3	+ 2.3	−20.4	−18.1
1931	80.2	93.4	− 6.6	−13.2	−19.8

* See footnote * to Table II.

It will be seen that, taking every year as a base for the year immediately succeeding, a number equal to or greater than those displaced during any one year (except the depression years 1921, 1924, 1927, 1930 and 1931) were absorbed during that year. Thus, if we apply the derived employment index (column 7, Table II) to the average number of wage earners during the year 1920 as reported by the United States Census of Manufactures for that year, we can estimate the actual number of those who were displaced as a result of the increased output per man-hour and the changes in employment as a result of changes in the physical volume of output. The 1920 Census of Manufactures reported 8,808,000 as the average number of wage earners on the payrolls. According to a compilation by the United States Bureau of Labor

Statistics the per cent of full-time operations during 1929 was 98.[1] If we apply this percentage to the census figure, we get an equivalent number of wage earners employed full-time of 8,632,000. Using this figure as a starting point we obtain the results given in Table IV.

Although, as was suggested above, during years of active business a number equal to those displaced was absorbed by the increase in output, this growth in the physical output was not once during the period 1920–1930 large enough to absorb a number equal to those displaced during the depression years as well. The number remaining unabsorbed fluctuated from year to year and amounted to approximately a half million in 1929, two millions in 1930, and three and one-third millions in 1931. If we cumulate the data in column 3, Table IV, and compare them with the cumulated data of column 4, Table IV (taking signs into consideration), we can observe the lag between displacement and absorption (see Table V).

TABLE IV

MANUFACTURING INDUSTRIES—YEAR TO YEAR CHANGES IN EMPLOYMENT, BY TYPES, 1920–1931

(1)	(2)	(3)	(4)	(5)	(6)
		Changes in employment (+) or (—)			
Year	Number of wage earners * employed in manufacturing industries	Due to changes in the output per man-hour **	Due to changes in physical volume of output	Net change during current year	Net change since 1920
1920	9,048,000	0	0	0	0
1921	6,840,000	—163,000	—2,045,000	—2,208,000	—2,208,000
1922	7,664,000	—935,000	+1,760,000	+ 824,000	—1,384,000
1923	8,831,000	—183,000	+1,350,000	+1,167,000	— 217,000
1924	7,971,000	—276,000	— 584,000	— 860,000	—1,077,000
1925	8,424,000	—495,000	+ 948,000	+ 453,000	— 624,000
1926	8,542,000	— 93,000	+ 211,000	+ 118,000	— 506,000
1927	8,270,000	— 68,000	— 204,000	— 272,000	— 778,000
1928	8,207,000	—503,000	+ 440,000	— 63,000	— 841,000
1929	8,632,000	—116,000	+ 541,000	+ 425,000	— 416,000
1930	7,067,000	+197,000	—1,762,000	—1,565,000	—1,981,000
1931	5,664,000	—467,000	— 936,000	—1,403,000	—3,384,000

* Note that these are full-time equivalents. The average number of wage earners as given by the census were: 1921—6,944,316; 1923—8,776,940; 1925—8,381,511; 1927—8,349,755; 1929—8,808,000.
** See footnote * to Table II.

Thus we note that by 1923 a number equal to 83 per cent of those displaced during the years 1921–1923 had been re-absorbed in manufacturing industries, while, if the period 1921–1925 is considered, only 70 per cent of the displaced were taken up by 1925. If, however, a time lag is allowed for the absorption process, it is found that of those

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[1] See United States Department of Commerce: *Survey of Current Business*, Annual Supplement, 1931, p. 180, Table 95.

TABLE V

MANUFACTURING INDUSTRIES—TIME LAG BETWEEN DISPLACEMENT AND ABSORPTION

(1)	(2)	(3)	(4)	(5)	(6)
Year	Cumulative effect of displacement factor (number of wage earners) *	Cumulative effect of absorption factor (number of wage earners) **	Per cent that col. (3) is of col. (2)	Per cent that col. (3) is when lagged one year behind col. (2)	Per cent that col. (3) is when lagged two years behind col. (2)
1920	0				
1921	— 103,000				
1922	—1,098,000				
1923	—1,281,000	+1,064,000	83	97	
1924	—1,547,000				
1925	—2,052,000	+1,428,000	70	92	111
1926	—2,146,000	+1,619,000	76	80	105
1927	—2,213,000				
1928	—2,710,000	+1,875,000	69	85	87
1929	—2,832,000	+2,416,000	85	89	109
1930	—2,975,000				
1931	—3,102,000				

* Column (3), Table IV, cumulated.
** Column (4), Table IV, cumulated.

displaced in the years 1921 and 1922, 97 per cent were absorbed one year later; of those displaced in 1921–1924, 92 per cent were taken in one year later and all had been absorbed two years later; on the other hand only 87 per cent of the victims of technical and managerial progress during the years 1921–1926 had found jobs as late as two years after their displacement. Even the peak year of 1929 had managed to absorb a number equal to only 89 per cent of those displaced between 1920–1928 within a lag of one year. These data seem to indicate that during the period 1920–1929, the process of absorption, when not impeded by cyclical recessions, lasted approximately one and one-half years.[1] A similar analysis, using monthly data, may disclose more accurate time relationships between these two factors in the fluctuations of employment.

The analysis described above was repeated on a cycle to cycle base, measuring cycles from peak to peak and giving the end years of a cycle only one-half the weight of the middle years. The results indicate first, that taking the recession as well as the revival years between 1920 and 1929 into consideration, the average number employed in manufacturing industries tended to increase until 1926. During the years 1926 to 1929, however, the absorptive capacity of the manufacturing industries had already begun to lag behind the displacement effects of the improved productive technology. Although the number of workers remaining unabsorbed during the period 1926 to 1929 was very small, amounting to approximately 8,000 or 0.1 per cent of the average number employed during 1923–1926, conclusions as to unemployment would be unwarranted since this analysis does not take into consideration either the growth of the population or occupational mobility; also, the time lag between displacement and absorption should be remembered. This lag results in unemployment which, depending upon the growth of the particular industry in which it occurs, and the age, adaptability, and other characteristics of the worker whom it strikes, may be of a permanent nature, may be extremely protracted, or of very short duration. The eventual absorption of a *number equal to those displaced* but not necessarily including those displaced is, of course, of small comfort to the victims of displacement.

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[1] The depression years 1921, 1924, 1927, and 1930–1931 were eliminated from the computations in Table V because the absorption process can be observed clearly only during years of active business while periods of recession either halt the process entirely or serve to slow the process down materially.

Class I Railroads.—In addition to the Manufacturing Industries, the factors influencing the volume and fluctuations in employment on Class I Railroads and in Coal Mining were subjected to a similar analysis. It was found that the principal difference between manufacturing and railroading is that manufacturing showed a tendency to absorb its displaced workers, while the railroads not only failed to absorb them but tended to add to those displaced because of technical and managerial improvements another group who cannot find employment on railroads as a result of a downward trend in the physical volume of output. Thus, a comparison between the cycle covering the years 1926–1929 and the preceding cycle 1923–1926 shows a total decline of about 230,000 workers or approximately 12 per cent of those employed during 1923–1926. This decline is made up of 130,000 who were displaced by increased technological and managerial efficiency and 100,000 who lost their jobs because of a drop in the physical volume of output.

What the results would be if the entire field of "Transportation" were taken into consideration can only be guessed at, though it is certain that the development of motor transportation served to offset, at least in part, the decline in employment on railroads.

Coal Industry.—Due to the nature of the underlying material the coal industry had to be divided into two separate industries: Bituminous and Anthracite.

The Bituminous Coal industry, not unlike railroads, shows a downward tendency in the physical volume of output. As a consequence, the diminution in the total number of wage earners in the industry is a resultant of the diminishing volume of output as well as of the increased mechanization of the industry and other factors making for a greater output per man-day. The decline in employment during the years 1926–1929 as compared with 1923–1926 amounted to about 20,000

TABLE VI

SUMMARY TABLE OF THE DISPLACEMENT OF WORKERS BY CHANGES IN TECHNOLOGICAL AND MANAGERIAL EFFICIENCY * AND THEIR ABSORPTION BY INDUSTRY

1921-1931

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Year	Manufacturing industries				Class I railways			
	Changes in employment		Net change		Changes in employment		Net change	
	Due to changes in the output per man-hour *	Due to changes in the physical volume of output	During current year	Since 1920	Due to changes in the output per man-hour *	Due to changes in the physical volume of output	During current year	Since 1920
1921	−163,000	−2,045,000	−2,208,000	−2,208,000	+ 2,000	−194,000	−192,000	−192,000
1922	−935,000	+1,759,000	+ 824,000	−1,384,000	−39,000	+100,000	+ 61,000	−426,000
1923	−183,000	+1,350,000	+1,167,000	− 217,000	−55,000	+286,000	+231,000	−191,000
1924	−276,000	− 584,000	− 860,000	−1,077,000	−47,000	−103,000	−150,000	−341,000
1925	−465,000	+ 918,000	+ 453,000	− 624,000	−82,000	+ 80,000	− 2,000	−316,000
1926	− 93,000	+ 211,000	+ 118,000	− 506,000	−29,000	+ 80,000	+ 51,000	−293,000
1927	− 68,000	− 204,000	− 272,000	− 778,000	+ 9,000	− 67,000	− 58,000	−350,000
1928	−503,000	+ 440,000	− 63,000	− 841,000	−71,000	− 8,000	− 79,000	−429,000
1929	−116,000	+ 541,000	+ 425,000	− 416,000	−26,000	+ 39,000	+ 13,000	−416,000
1930	+197,000	−1,762,000	−1,565,000	−1,981,000	+12,000	−233,000	−221,000	−637,000
1931	−467,000	− 936,000	−1,403,000	−3,384,000	+ 1,000	−273,000	−272,000	−909,000

* See footnote * to Table II.

** Totals of Bituminous and Anthracite Coal.

† Not including the coal industry, for which the 1931 figures were not yet available at the time of writing.

†† Not including the 1931 decline in the coal industry (see footnote †) but including the decline in the coal industry from 1920 to 1930, i.e. 261,000 workers.

or approximately 4 per cent. Seventeen thousand of this number were displaced by changes in the output per man-day while 3,000 were dropped as a result of a decline in output.

An analysis of material covering other industries engaged in the supply of power, light and heat from sources other than coal, might well show an increase in numbers employed as large or larger than the decline in bituminous coal.

The Anthracite industry, too, suffers from the declining volume of output. Unlike, however, any of the preceding industries, the Anthracite industry seems to show a decline in output per man-day rather than an increase. This is due not to neglect in the mechanization process of the industry, but in part to the increasing inaccessibility of the coal to be mined and in part to a slight incomparability of the data.[1] Another peculiarity of the industry is that its fluctuations in output and employment are influenced most markedly not by the course of general business conditions but by the duration of the agree-

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[1] Beginning with 1923, a small tonnage of culm-bank coal handled through breakers and hitherto counted as fresh-mined coal has been excluded, the figures on output per man-day are therefore not exactly comparable with earlier years; the difference, however, is small. (See U. S. Department of Labor, *Monthly Labor Review*, February, 1932, p. 202.)

TABLE VI—*Continued*

SUMMARY TABLE OF THE DISPLACEMENT OF WORKERS BY CHANGES IN TECHNOLOGICAL AND MANAGERIAL EFFICIENCY * AND THEIR ABSORPTION BY INDUSTRY

1921–1931

Year	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
	Coal industry**				Totals for the group of industries			
	Changes in employment		Net change		Changes in employment		Net change	
	Due to changes in the output per man-day *	Due to changes in the physical volume of output	During current year	Since 1920	Due to changes in technological and managerial efficiency *	Due to changes in the physical volume of output	During current year	Since 1920
1921 . . .	−15,000	−165,000	−180,000	−180,000	−179,000	−2,701,000	−2,880,000	−2,880,000
1922 . . .	−27,000	− 62,000	− 89,000	−269,000	−998,000	+1,797,000	+ 799,000	−2,081,000
1923 . . .	−15,000	+224,000	+209,000	− 60,000	−250,000	+1,860,000	+1,610,000	− 471,000
1924 . . .	+ 8,000	− 94,000	− 86,000	−146,000	−316,000	− 781,000	−1,097,000	−1,568,000
1925 . . .	− 7,000	− 19,000	− 26,000	−172,000	−584,000	+1,010,000	+ 426,000	−1,142,000
1926 . . .	+ 5,000	+102,000	+107,000	− 65,000	−127,000	+ 406,000	+ 279,000	− 863,000
1927 . . .	−11,000	− 66,000	− 77,000	−142,000	− 70,000	− 337,000	− 407,000	−1,270,000
1928 . . .	−21,000	− 25,000	− 46,000	−188,000	−598,000	+ 410,000	− 188,000	−1,458,000
1929 . . .	−12,000	+ 29,000	+ 17,000	−171,000	−164,000	+ 619,000	+ 455,000	−1,003,000
1930 . . .	−23,000	− 70,000	− 93,000	−264,000	+186,000	−2,065,000	−1,879,000	−2,882,000
1931 . . .	....	....	....	....	−475,000†	−1,200,000†	−1,675,000†	−4,557,000†

ments between the coal mine operators and the dominant trade union organization. The total decline in employment in this industry is approximately 34,000 since 1920, all of which is the result of losses incurred since 1927, and is due almost wholly to a drop in the volume of output.

A summary of the effects of the depression years 1930 and 1931 upon the state of employment in the group of industries included in this analysis, presents the following picture. (See Table VI.)

During the two years, 1930 and 1931, approximately 2,700,000 workers in the manufacturing industries lost their jobs as a result of the drop in the volume of output. In addition to that, about 270,000 were displaced as a result of such technological and managerial improvements as brought about an increase in the output per man-hour. Close to three million workers, or approximately 34 per cent of those who had been employed in manufacturing industries in 1929, were therefore dropped from the payrolls. These figures include partial as well as complete losses of employment, i.e., they are in terms of full-time employment equivalents.

On Class I Steam Railroads the drop in employment during 1930 and 1931 amounted to about half a million workers or 30 per cent of those employed in 1929, and was due wholly to the decline in the volume of output. In point of fact, the output per service-hour *declined* during the two years, thus counteracting the drop in output to the extent of approximately 13,000 employees.

At this writing the coal data for 1931 are not yet available, but a group total including the coal industry up to and including the year 1930, indicates that in the three industries, manufacturing, railroading and coal mining, some three and a half million or one-third fewer workers were employed in 1931 than in 1929.

Conclusions.—The preceding analysis was undertaken in an attempt to devise a statistical method for the measurement of the influence exerted upon the level of employment by technological and managerial improvements. Although the procedure used in this essay cannot be said to have solved the problem, it is offered as one approach to the question, adapted to the present status of statistical information bearing on factors relating to employment. The results of this analysis, qualified as they are by the deficiencies of the underlying statistical data as well as by those of the statistical procedure, nevertheless establish certain relationships, warrant a number of definite conclusions, and raise a series of significant questions.

1. The first thing that stands out when the rate of increase of the output per man-hour in the manufacturing industries is analyzed, is the fact that this rate tends to diminish during years of active business and to accelerate under the pressure of business depressions.

2. Second, certain definite relationships between the rate of increase of the output per man-hour, the physical volume of output, and the labor supply become evident. These relationships may be stated in the following terms:

A. Given a continuously rising output per man-hour,

a. An increase in the physical volume of output is accompanied by a *less* than proportionate increase in the volume of employment.

b. A decline in the physical volume of output results in a *more* than proportionate shrinkage in employment.

B. In order that the so-called "labor reserve" either diminish or remain numerically constant in size, in a country with an increasing number seeking gainful employment and a progressive technology, the following conditions must obtain:

a. The physical volume of output must increase at a faster rate than the increase in the output per man-hour.

b. The relationships among the three factors: physical volume of output, output per man-hour and labor supply, must be as follows:

$$\left.\frac{\text{Index of Physical Volume of Output}}{\text{Index of Output per Man-Hour}}\right\} \geq \text{Index of Labor Supply}$$

c. If the two conditions given above do not obtain, some other compensatory action becomes necessary. Such action might well be in the direction of a curtailment of the standard number of hours per work-week, or a reduction of the number of persons entering the labor market, by means of a withdrawal from the labor market, through legislative means or otherwise, of a number of persons below and above certain age limits.

3. Third, so far as manufacturing industries are concerned, the evidence based on the comparatively short period, 1920–1931, is not conclusive enough to warrant the statement that the increased output per man-hour has resulted in a permanent displacement of workers. In fact, the analysis indicates that during the period 1920–1926 a number *greater* than that displaced by the increased output per man-hour was absorbed by the increased physical volume of output, while the years 1926–1929 failed to absorb only approximately one-tenth of one per cent of those displaced.

4. Although there seems to have been little if any permanent displacement in manufacturing industries, temporary displacement played an important rôle in the fluctuations in employment. During the period 1920–1931, over three million wage earners were displaced because of increases in technological or managerial efficiency, or, an average of about a quarter of a million wage earners a year.

5. This quarter of a million was eventually reabsorbed; some of these workers indeed may never have lost their jobs at all. And yet, if it is recalled that the absorption process took one and one-half years or thereabout to work itself out (see Table V), then the average time lost per displaced worker was approximately three-quarters of a year.[1]

6. Whereas the simultaneous processes, displacement and absorption, tended to cancel each other in the long run when all manufacturing industries are lumped together, this is certainly not the case with individual industries. What was true of railroads and bituminous coal was doubtless also true of a number of manufacturing industries. In order to determine the industries in which the rate of displacement was creating "disemployed" groups of workers it would be necessary to perform this type of analysis for separate industries or groups of industries. Such an investigation should also attempt to determine whether the

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[1] Another study on the absorption of displaced workers shows that out of the 754 discharged workers, only 381, or a little over 50 per cent had found jobs in less than nine months of unemployment. See, Isador Lubin, *The Absorption of the Unemployed by American Industry*, The Brookings Institution, Washington, D. C., 1929.

shifting of workers from one industry to another (as a result of displacement and absorption) was predominantly from industries paying comparatively high rates of wages to industries with lower wage levels, or vice versa; whether labor was shifted from industries with a comparatively small number of standard hours per work week to industries with a larger number of full-time hours per week, etc. Furthermore, a study based upon monthly data rather than annual material may well disclose significant relationships which are obscured when yearly figures are used.

7. Finally, the caution bears repeating that, since this study takes neither the mobility of labor (from industries here covered to other industries such as commerce, finance, insurance, personal and professional services, etc.) nor the growth of the population into consideration, conclusions concerning numbers unemployed are unwarranted.

THE EFFECT OF ALLOCATION OF NON-RESIDENT DEATHS UPON OFFICIAL MORTALITY STATISTICS[1]

BY HAROLD F. DORN

Because of the difficulty of collecting original data, students in the fields of population and vital statistics must rely almost entirely upon the official publications of government agencies. In view of this fact it is unfortunate that official statistics are often published in forms that make them of little value for research purposes or that grossly misrepresent the actual situation. This is particularly true of official vital statistics.

The increasing hospitalization of recent years has attracted many rural and small village residents to the larger, better-equipped urban centers for medical treatment. A considerable number of the births and deaths now occurring in cities, particularly in those with superior hospital and medical facilities, are of non-resident rural people, causing both the birth and death rates of such cities to be unduly increased. On the other hand, the location of sanatoria, and state hospitals and institutions in rural territory markedly affects the recorded vital statistics of such areas. Thus the death rate from tuberculosis may be higher in the country than in the city due to location of sanatoria in rural areas, while the death rate from cancer and appendicitis in the city is probably increased by deaths of rural residents seeking hospital service there. The publication of official vital statistics without correction for residence not only misrepresents the actual situation, but makes such data worthless for detailed research involving areas smaller than states. The Bureau of the Census has very carefully discussed this fact in each of the annual reports of mortality statistics since 1918 but other than publishing the total recorded and resident deaths for the rural and urban parts of each registration state, it has made no corrections in the published data.

Since the pioneering study of Dr. Eichel[2] in New York State in 1919, several individual research projects showing the effect of non-resident deaths on the mortality statistics of selected areas have appeared.[3]

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[1] This study was financed by the Scripps Foundation for Research in Population Problems. The data were made available through the courtesy of Mr. I. C. Plummer, Chief of the Division of Vital Statistics, State of Ohio.

[2] O. R. Eichel, "So-Called Non-Resident Deaths—A Preliminary Note on an Experimental Study of This Subject in New York State," *American Journal of Public Health*, IX, 9, 654–662, 1919.

[3] D. G. Wiehl, "The Correction of Infant Mortality Rates for Residence," *American Journal of Public Health*, XIX, 495–510, 1929.

In 1926 the report of the Division of Vital Statistics of New York State contained crude resident and recorded mortality rates for the total population by size of community for all causes of death and for tuberculosis separately. In the 1927 report recorded and resident mortality rates for cancer, automobile accidents allocated to place of occurrence, and infant and maternal mortality were added, and in 1929 deaths from typhoid fever and diphtheria as corrected for the place of contraction of the disease. In addition, DePorte has published articles concerning the effect of non-resident deaths on the mortality rates of certain diseases in New York State.[1]

The above-mentioned studies have dealt either with crude mortality rates for all causes of death, or when the data have been presented by sex or age, only with specific diseases such as tuberculosis. Because of the absence of published mortality rates based on resident deaths and classified by age, sex, color, nativity of whites, and cause of death for different types of communities, this study was undertaken.

The death certificates for the entire state of Ohio for 1930 were searched for deaths of persons who were non-resident of the areas from which the deaths were reported. The data for such deaths were punched on tabulating cards and the death records for the state retabulated on the basis of the residence of the deceased. The tabulation was made by sex, age, color, nativity of whites, and cause of death for the rural population, urban places of 2,500 to 10,000 population, of 10,000 to 100,000 population, and 100,000 population and over for each of the eighty-eight counties of the state. A detailed comparison of the mortality rates based on this classification will be published later, as this report is concerned only with showing the effect of the allocation of non-resident deaths.

It should not be assumed that a resident mortality rate gives a "true" picture of the actual mortality conditions in any place. While recorded rates presuppose that all deaths of non-residents are chargeable to the place of occurrence, resident rates presuppose that none of those deaths is the result of local environment or treatment and that it

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Jean Downes, "The Accuracy of Official Tuberculosis Rates," this JOURNAL, XXVI, 176, 393-408, 1931.

E. H. Pennell, "Deaths of Nonresidents in Syracuse," Milbank Memorial Fund, *Quarterly Bulletin*, X, 3, 212-220, 1932.

Edgar Sydenstricker, "The Trend of Tuberculosis Mortality in Rural and Urban Areas," *American Review of Tuberculosis*, XIX, 461-482, 1929.

[1] J. V. DePorte, "Recorded and Resident Death Rates from Tuberculosis in New York State in 1926," *American Review of Tuberculosis*, XVII, 634-662, 1928.

———, "Extent to Which Residence Influences the Recorded Death Rates from Cancer in the State of New York," *American Journal of Hygiene*, X: 1, 1929.

———, "Some Aspects of the Recorded and Resident Mortality from Tuberculosis in New York State in 1927 and 1928," *American Review of Tuberculosis*, XXII, 87-115, 1930.

would have occurred if the deceased were at home. Obviously this is not strictly true, especially for deaths due to accidental causes, but it is maintained that a resident rate is more representative of the actual mortality conditions than a rate based on recorded deaths.

In the previous studies, the question has been raised as to the method of allocating deaths. DePorte allocated deaths due to automobile accidents to the place of occurrence, deaths due to typhoid fever and diphtheria to the place of contraction of the disease, infant deaths to the residence of the mother, and other deaths to the usual place of abode as stated on the death certificate. Deaths in tuberculosis sanatoria were allocated to the place of residence prior to admittance to the sanatoria.

The rules followed in this study were essentially those adopted by the Bureau of the Census with a few exceptions. Deaths in tuberculosis sanatoria were allocated to the residence of the deceased prior to his admittance to the sanatorium. Because of the absence of health resorts similar to those in the Adirondack Mountains of New York, the problem of the allocation of deaths of temporary residents of such places was not involved. Infant deaths were allocated to the residence of the parents, or to that of the mother in certain cases. Because of the difficulty of deciding the residence of inmates, particularly of those who had been in an institution for five or ten years, deaths in state hospitals and institutions, and county homes and infirmaries were tabulated separately as institutional deaths and were not included in the deaths of the areas in which the institutions were located. Otherwise a non-resident death was defined as a death recorded at a place other than the usual place of abode as stated on the death certificate. In a few cases the resident address was not given and no allocation was made. To be consistent with the census definition of residence followed in population enumeration, it was decided to allocate all deaths to the usual place of abode rather than to distribute deaths to the usual place of abode, place of accident, or contraction of disease. The information necessary for the latter was in most cases lacking and, while there is some question as to where an accidental death should be recorded, it was decided to be consistent with the enumeration of population. An accidental death is not only the result of the immediate environment at the time but also of the habits, reaction time, and physical and mental condition of the person involved, all of which are related to his home environment. Which should receive credit for the death is a moot question.

Deaths of out-of-state residents were discarded. No correction was made for the deaths of Ohio residents occurring in other states. It is believed that the number of such deaths was not large because of the absence of large cities near the Ohio border in adjoining states, with the possible exception of Wheeling and Huntington, West Virginia. Due to the location of Cincinnati, Cleveland, and Toledo, all near the state line, Ohio probably draws many more residents from other states than the adjacent states draw from Ohio.

The allocation of non-resident deaths was not perfect for rapidly growing cities and for cities separated only by a political boundary. Around a rapidly growing city, streets often are extended beyond the city boundaries. When the street address was given and no indication as to whether or not the residence was within the city boundary or outside, the death was credited to the city as recorded. In this way a few deaths of rural persons (as defined by the census) were included in the urban population, but since these were in reality residents of the city it is believed no bias was introduced into the data. Difficulties also arose where a suburb was located immediately adjacent to a larger city as, for example, Bexley adjoining Columbus, where only a political boundary separates the two places. In some instances the proper city was not indicated on the death certificate, only the street address being given. In this way some deaths of residents of suburban areas were probably included among the deaths of the larger city; but upon checking the number of deaths in these smaller places, it is very doubtful if the number was large.

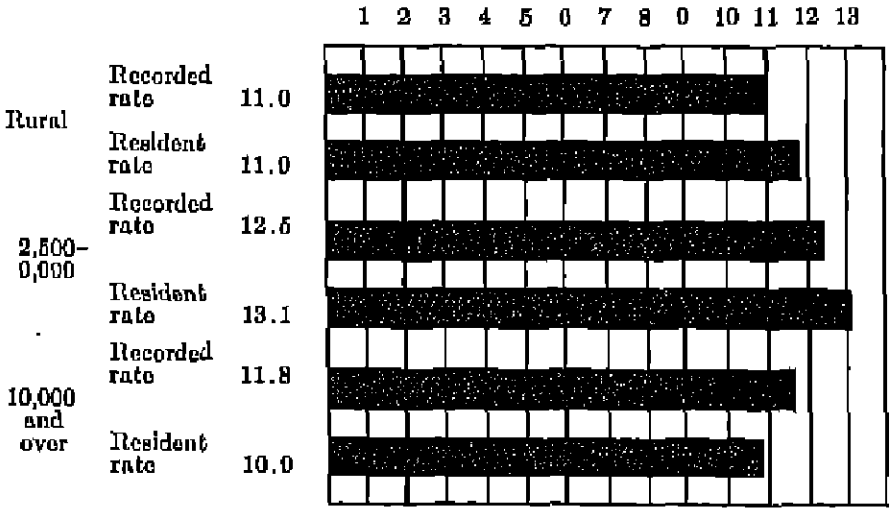
Such cases are mentioned, not because they are a large proportion of the number of cases, but because they illustrate the difficulty of determining what is and what is not a non-resident death, and what is to be done with it after it has been discovered. In spite of these difficulties and the slight inaccuracies due to them, the resultant resident mortality rate is doubtless more representative of the prevailing conditions than the original recorded rate.

The allocation of deaths was by primary registration districts; that is, townships, incorporated villages, and cities. Consequently the deaths allocated to rural territory did not all occur in urban territory but may have occurred in a different rural township of the same county or of a different county. The same applies to each of the different sized communities. This gives the true number of non-resident deaths, but means that deaths were both added to and subtracted from many of the areas.

Of the 70,210 deaths recorded in Ohio in 1930, 6,731 or 9 per cent were non-resident of the primary registration areas from which they were reported, and 922 or 14 per cent of the non-resident deaths were of residents of other states. The distribution of non-resident deaths was

CHART I

RECORDED AND RESIDENT CRUDE DEATH RATES PER 1,000 TOTAL POPULATION FOR THE RURAL POPULATION AND CITIES OF 10,000 POPULATION AND OVER, AND PER 1,000 NATIVE WHITE POPULATION FOR URBAN PLACES OF 2,500–9,999 POPULATION; OHIO, 1930



very unequal throughout the state. In some of the more rural areas where it is several miles to hospital facilities, the number of non-resident deaths was small, while around the large cities the number was large. In Hamilton County where Cincinnati is located, the number of deaths allocated to the rural part of the county was 48 per cent of the total number of deaths recorded in rural territory; in Cincinnati 12 per cent of the recorded deaths were non-resident. After deducting the deaths due to the Ohio penitentiary fire, 15 per cent of the recorded deaths in Columbus were non-resident; in Toledo 10 per cent of the recorded deaths were non-resident, while the deaths allocated to the rural part of the county (in which Toledo is located) were 30 per cent of the total recorded deaths. Although these are some of the extreme instances, they serve to indicate the extent of the problem in certain areas.

Chart I shows the recorded and resident mortality rates per 1,000 total population for the rural population, places of 2,500 to 10,000 population, and cities of 10,000 population and over. It should be remembered that crude rates are very unreliable indices for comparison of communities with unlike age, sex, nationality, racial, and occupational composition. Specific age, sex, and nativity rates will be presented later, but the crude rates show the differences due to allocation of non-resident deaths. Whereas the rural rate was increased about 8 per cent and the rate for places of 2,500 to 10,000 population increased about 5 per cent, the rate for the cities of 10,000 population or over was *decreased* about 8 per cent.

The resident rate was higher than the recorded rate for the rural

TABLE I

RECORDED AND RESIDENT DEATHS AND DEATH RATES PER 100,000 TOTAL POPULATION FOR SELECTED CAUSES OF DEATH, OHIO, 1930

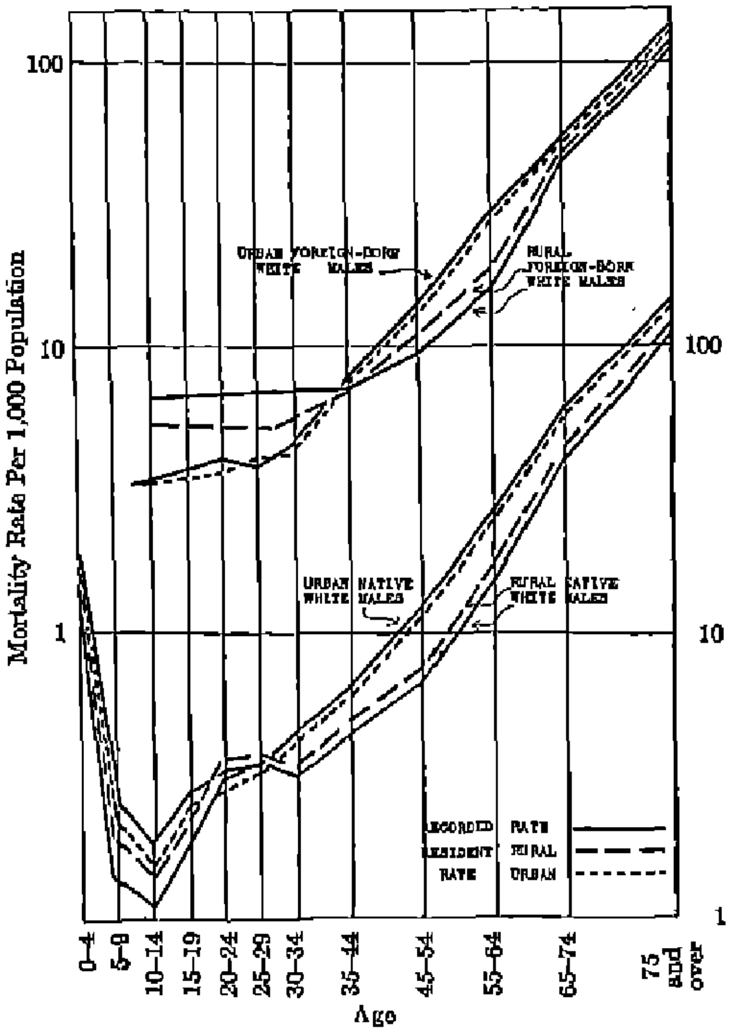
International list number, 1929 revision	Cause of death	Urban					Rural				
		Number of recorded deaths †	Number of resident deaths †	Recorded rate	Resident rate	Per cent change	Number of recorded deaths †	Number of resident deaths †	Recorded rate	Resident rate	Per cent change
11, 107, 108, 109	Influenza, pneumonia (all forms)	4,284	4,079	95.0	90.5	− 5	1,943	2,111	90.8	98.7	+ 9
23–32	Tuberculosis (all forms)	2,688	2,868	59.6	63.6	+ 7	1,243	1,028	58.1	48.1	− 17
45–53	Cancer (all forms)	4,973	4,678	110.3	103.8	− 6	1,974	2,190	92.3	102.4	+ 11
59	Diabetes mellitus	1,064	997	23.6	22.1	− 6	365	418	17.1	19.5	+ 14
82	Cerebral hemorrhage, embolism, and thrombosis	4,339	4,228	96.3	93.8	− 3	2,609	2,683	122.0	125.4	+ 3
90–95	Heart disease	9,854	9,590	218.6	212.8	− 3	4,575	4,729	213.9	221.1	+ 3
117, 118	Ulcers and other diseases of stomach and duodenum	469	407	10.4	9.0	−13	157	209	7.3	9.8	+ 34
119, 120	Diarrhea and enteritis	964	891	21.4	19.8	− 7	500	549	23.4	25.7	+ 10
121	Appendicitis	950	742	21.1	16.5	−22	64	245	3.0	11.5	+283
122, 123	Hernia and other diseases of intestines	664	545	14.7	12.1	−18	107	210	5.0	9.8	+ 96
124–127	Diseases of liver and gall bladder	614	532	13.6	11.8	−13	237	304	11.1	14.2	+ 28
130–133	Nephritis, and other diseases of kidneys and ureters	3,734	3,562	82.8	79.2	− 4	1,580	1,704	73.9	79.7	+ 8
140–150	Diseases of pregnancy, childbirth, and puerperal state	570	493	6.7*	5.8*	−13	113	208	3.3*	5.5*	+ 67
163–175	Suicides, homicides	1,346	1,278	29.9	28.4	− 5	436	455	20.4	21.3	+ 4
210	Automobile accidents (primary)	1,604	1,384	35.6	30.7	−14	472	584	22.1	27.3	+ 24
176 and over	Accidents, excluding automobile	3,085	2,812	68.4	62.4	− 9	1,429	1,602	66.8	74.9	+ 12

* Rate per 1,000 live births. Data for births taken from an unpublished tabulation by Mr. P. G. Beck of Ohio State University in cooperation with Scripps Foundation for Research in Population Problems.

† Exclusive of institutional deaths.

CHART II

RECORDED AND RESIDENT DEATH RATES PER 1,000 POPULATION FOR NATIVE AND FOREIGN-BORN WHITE MALES, RURAL AND URBAN, OHIO, 1930

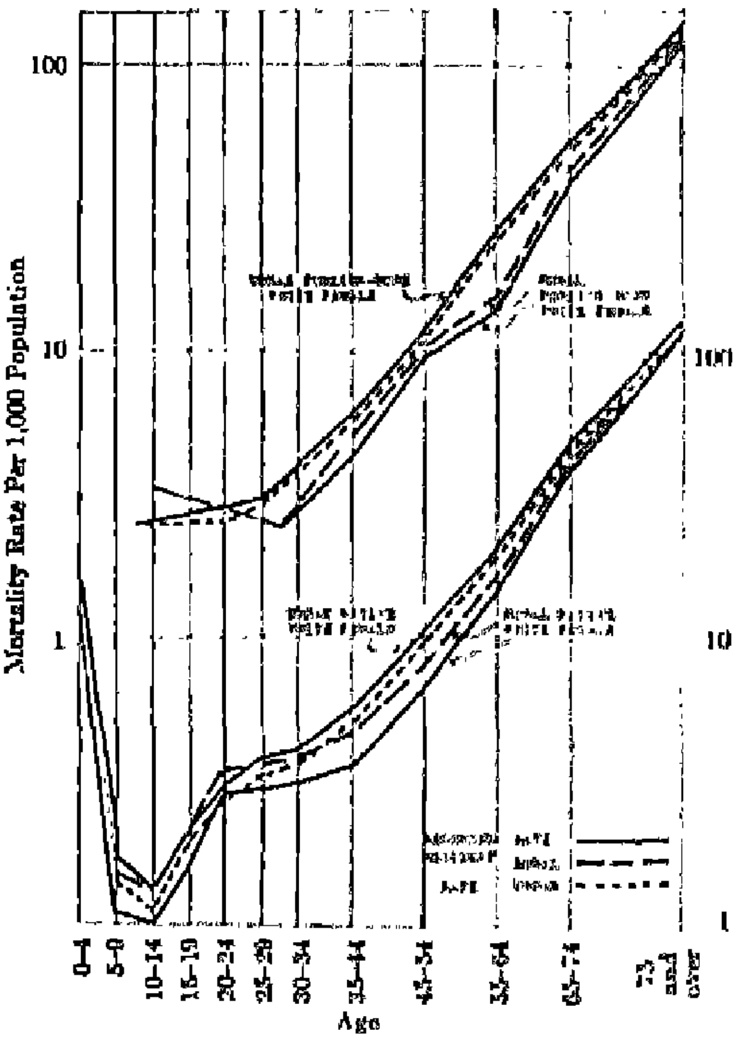


population of 85 of the 88 counties. The higher recorded rate in the rural part of two of the counties was due to the location of tuberculosis sanatoria, while that for the third was due to a rural hospital. In the majority of the places of 2,500 to 10,000 population the resident rate was higher than the recorded rate, but in some, especially where such places were the only urban places in the county and had the only hospital, the recorded rate was higher. With only three exceptions, the resident rate of the cities of 10,000 population or over was lower than the recorded rate.

The inaccuracy of the recorded rates for specific diseases is clearly shown by Table I which gives the differences between the recorded and resident rates for several diseases and groups of diseases in rural and urban communities. It should be remembered that the differences in the urban rates are lessened somewhat by the inclusion of places of

CHART III

RECORDED AND RESIDENT DEATH RATES PER 1,000 POPULATION FOR NATIVE AND FOREIGN-BORN WHITE FEMALES, RURAL AND URBAN, OHIO, 1930



2,500 to 10,000 population; but even so, the changes are marked. The rates shown are crude rates, so that the differences between the urban and rural rates may be reversed when corrected for age, sex, and nativity; but the recorded and resident rates for the same community can be fairly compared. With the exception of tuberculosis, each of the resident rates for the rural population is higher than the recorded rate, the percentage increase ranging from 4 per cent for suicide and homicide to 283 per cent for appendicitis. For the important diseases the increases were 8 per cent for nephritis and other diseases of the kidneys and ureters, 12 per cent for accidental deaths exclusive of automobile accidents, 11 per cent for cancer, and 9 per cent for influenza and pneumonia. In contrast to these increases the rate for tuberculosis was *decreased* 17 per cent.

The changes in the urban rates were the direct opposite of those for the rural, the resident rates being lower than the recorded rates for all the diseases except tuberculosis for which the recorded rate was *increased* 7 per cent. The percentage differences for the urban rates were somewhat less than those for the rural rates, ranging from a decrease of 3 per cent for heart disease and cerebral hemorrhage to a decrease of 22 per cent for appendicitis. The largest decreases were in the rates for automobile accidents, diseases of the liver and gall bladder, hernia and other diseases of the intestines, appendicitis, ulcers and other diseases of the stomach and duodenum, and diseases of pregnancy, childbirth, and puerperal state.

Rates, both recorded and resident, have been computed by nativity of white and by color but, since these show that most of the difference between the recorded and resident rates is due to the native white deaths, they are not presented here. The rural foreign-born white and colored rates changed much more than the native white rate for tuberculosis, the decreases being 33, 55, and 10 per cent respectively. The important differences for the rural foreign-born white population were increases of 11 per cent in the rate for cancer, 21 per cent for diabetes mellitus, and 10 per cent for nephritis and other diseases of the kidneys and ureters. Except for increases of 14 per cent in the rate for cerebral hemorrhage, 9 per cent in the rate for heart disease, and 17 per cent in the rate for accidental deaths there was practically no change in the rates for the rural colored population. The changes in the rates for the rural native white population correspond very closely to those in the rates for the total population. The same general considerations are also true for the urban native white, foreign-born white, and colored populations.

The allocation of births and infant deaths to the residence of the mother increases the disparity between the infant mortality rates of rural and urban areas (Table II). The recorded rural white infant

TABLE II

RECORDED AND RESIDENT DEATHS UNDER ONE YEAR OF AGE AND INFANT MORTALITY RATES, BY COLOR, FOR THE RURAL AND URBAN POPULATION, OHIO, 1930 *

	White		Colored		White		Colored	
	Recorded rate	Resident rate	Recorded rate	Resident rate	Number of recorded deaths	Number of resident deaths	Number of recorded deaths	Number of resident deaths
Urban.......	58.2	57.3	104.4	102.0	4,531	4,241	580	578
Rural.......	60.2	61.0	88.4	98.0	2,022	2,201	40	58

* Recorded and resident births taken from an unpublished tabulation made by Mr. P. G. Beck of Ohio State University in coöperation with the Scripps Foundation for Research in Population Problems.

TABLE III

RECORDED AND RESIDENT DEATHS AND DEATH RATES PER 1,000 POPULATION BY AGE, SEX, COLOR, AND NATIVITY OF WHITE, FOR THE RURAL POPULATION, OHIO, 1930*

Age	White								Colored			
	Native†				Foreign born				Male		Female	
	Male		Female		Male		Female					
	Recorded	Resident	Recorded	Resident	Recorded	Resident	Recorded	Resident	Recorded	Resident	Recorded	Resident
	Numbers											
0- 4	1,470	1,671	1,191	1,358					37	60	25	27
5- 9	161	215	121	162								
10-14	127	163	100	139	21	17	9	9	14	17	2	4
15-19	185	223	148	185								
20-24	245	285	193	232					40	24	37	23
25-29	222	234	183	221								
30-34	195	210	189	232	38	28	13	13	48	37	16	5
35-44	531	594	419	552	91	90	41	47	53	48	22	21
45-54	723	824	698	811	123	145	85	91	44	49	23	26
55-64	1,330	1,480	1,143	1,285	136	157	82	91	45	45	20	10
65-74	2,408	2,587	1,956	2,018	240	258	148	153	43	45	20	21
75 and over	2,813	3,026	2,846	2,805	334	347	307	309	41	43	32	33
Total	10,410	11,421	9,103	10,100	983	1,042	685	713	365	358	197	178
	Rates											
0- 4	14.6	16.5	12.3	13.8					20.9	28.2	13.8	14.9
5- 9	1.4	1.9	1.1	1.5								
10-14	1.1	1.4	1.0	1.3	6.6	5.3	3.3	3.3	3.7	4.4	1.0	1.1
15-19	1.8	2.2	1.6	2.1								
20-24	3.1	3.6	2.8	3.4					9.0	5.9	12.5	7.4
25-29	3.5	3.7	3.0	3.6								
30-34	3.1	3.4	3.1	3.8	7.1	6.2	2.4	2.4	14.0	11.3	6.5	2.0
35-44	4.3	4.9	3.5	4.7	7.1	7.0	4.2	4.9	18.1	16.4	10.1	9.6
45-54	6.6	7.6	6.8	8.0	9.6	11.3	9.9	10.6	18.6	20.7	14.6	16.4
55-64	15.0	16.8	14.7	16.6	16.4	18.9	14.2	15.8	31.2	31.2	21.2	20.2
65-74	40.8	43.8	38.5	40.3	43.4	46.6	39.3	40.7	49.0	51.0	36.4	38.2
75 and over	113.3	117.8	110.6	121.7	114.6	119.0	128.1	128.0	94.9	99.5	107.0	110.4
Total	10.0	11.0	9.6	10.5	10.2	20.4	17.0	18.6	17.4	17.0	11.9	10.8
Adjusted Rate ‡		8.7		8.3		9.6		7.7		15.0		10.3

* Excluding institutional deaths. The population has been corrected for residents of state hospitals and homes for the feeble-minded and epileptic.

† Includes whites of unknown nativity.

‡ Based on the standard million population of England and Wales, 1901.

mortality rate was 3 per cent higher than the corresponding urban rate, while the resident rural white infant mortality rate was 6 per cent greater than the resident urban rate. The resident mortality rate for rural colored infants is lower than the corresponding urban rate, but the number of births and deaths is rather small to give conclusive evidence. These differences are in general agreement with the findings of DePorte in New York State where the rural resident infant mortality

TABLE IV

RECORDED AND RESIDENT DEATHS AND DEATH RATES PER 1,000 POPULATION BY AGE, SEX, COLOR, AND NATIVITY OF WHITE, FOR THE URBAN POPULATION, OHIO, 1930 *

Age	White								Colored			
	Native †				Foreign born							
	Male		Female		Male		Female		Male		Female	
	Recorded	Resident	Recorded	Resident	Recorded	Resident	Recorded	Resident	Recorded	Resident	Recorded	Resident
	Numbers											
0– 4	3,246	3,008	2,562	2,375	41	41	32	32	424	400	340	344
5– 9	485	410	316	205					44	43	41	40
10–14	318	275	235	199					33	32	30	38
15–19	470	408	386	341					60	70	91	98
20–24	553	484	570	507	53	48	30	35	131	132	145	151
25–29	544	501	503	536	81	82	63	61	172	172	147	161
30–34	624	584	572	522	132	122	108	100	210	210	182	187
35–44	1,620	1,470	1,304	1,227	677	665	372	356	400	450	374	373
45–54	2,205	2,031	1,952	1,770	977	947	583	505	400	401	342	338
55–64	2,978	2,705	2,510	2,330	1,089	1,002	802	787	299	300	200	199
65–74	3,409	3,231	3,251	3,120	1,098	1,070	1,011	998	183	160	178	174
75 and over	2,782	2,645	3,334	3,251	1,075	1,054	1,311	1,301	121	120	121	121
Total	19,204	17,810	17,082	16,484	5,223	5,001	4,321	4,241	2,651	2,630	2,206	2,214
	Rates											
0– 4	18.5	17.1	15.1	14.0	3.3	3.3	2.5	2.5	34.3	33.1	27.4	27.2
5– 9	2.5	2.2	1.7	1.4					3.5	3.4	3.1	3.0
10–14	1.8	1.6	1.3	1.1					3.3	3.2	3.7	3.6
15–19	2.8	2.5	2.1	1.9					7.3	8.4	8.3	9.0
20–24	3.3	2.8	3.1	2.7	4.1	3.7	2.8	2.5	10.3	10.4	10.4	10.8
25–29	3.5	3.2	3.7	3.3	3.9	4.0	3.0	2.9	10.6	10.6	9.1	9.4
30–34	4.4	4.1	4.0	3.6	4.5	4.2	4.0	3.9	14.2	14.4	13.3	13.6
35–44	6.5	5.9	5.5	4.8	7.5	7.4	5.7	5.5	16.0	16.8	16.0	16.6
45–54	12.3	11.4	10.6	9.8	14.2	13.8	11.5	11.1	30.0	30.4	27.6	27.3
55–64	29.6	24.7	20.7	19.2	29.4	28.7	25.2	24.7	40.5	40.7	38.3	38.1
65–74	61.5	57.3	46.6	44.7	53.2	51.8	50.9	50.2	80.5	79.2	77.3	75.5
75 and over	146.0	138.8	122.1	119.0	138.1	135.4	135.4	134.4	135.7	134.5	119.8	119.8
Total	10.7	9.9	9.5	8.8	17.0	17.0	17.1	16.8	18.7	18.6	16.4	16.4
Adjusted Rate ‡		10.4		8.6		9.8		8.5		20.3		18.3

* Excluding institutional deaths. The population has been corrected for residents of state hospitals and homes for the feeble-minded and epileptic.

† Includes whites of unknown nativity.

‡ Based on the standard million population of England and Wales, 1901.

rate was higher than the urban resident infant mortality rate for both 1929 and 1930.[1]

The discrepancy between the recorded and resident rates is further illustrated by the age specific rates for the native white, foreign-born white and colored populations. The general tendency is to decrease the difference between the rural and urban groups. Whereas the recorded deaths show that the mortality rates at all ages are less for rural than urban native white males, the resident rates for age groups, 20–24 and 25–29, are less for the urban than for the rural. Considering the native white females, we find that the relative standing is again reversed for the age groups from 5 to 35 years, the resident urban rates being less than the resident rural rates for this period while the recorded rates show the opposite to be true. For the other ages the resident rural rates are less than the resident urban rates except for the ages above 75 years for the native white females.

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[1] New York State Department of Health, *Fifty-First Annual Report*, Vol. 2, pp. lxxix–xciv, 1930.

While the urban rates are lower than the rural rates in the younger age groups for the foreign-born white males and females, due to the small number of deaths in the rural population no definite conclusions can be drawn. During the adult and old age groups the resident rural rates are lower than the resident urban rates.

Due primarily to the allocation of deaths from tuberculosis the resident rates for the urban colored males and females are higher than the recorded rates from ages 5 to 35 years. This makes the difference between the mortality rates for the rural and urban colored populations even greater than shown by the recorded rates. For the remainder of the age groups the effect of the allocation of non-resident deaths is to decrease the difference between the rural and urban rates, with the rural resident rates less than the urban resident rates, although here again the number of deaths in the rural population is too small to warrant definite conclusions for the younger age groups.

These data should make perfectly evident the unreliability of conclusions drawn from recorded mortality statistics when comparing areas smaller than states as a whole. Since the difference between the recorded and resident rates varies for different causes of death, for the two sexes, and for the separate nativity and racial groups there seems to be no alternative except to tabulate mortality statistics by residence of the deceased, if one wishes to avoid misinterpretation of the data.

Date 18
N. C.

SUMMATION METHODS IN FITTING PARABOLIC CURVES

By Frederick F. Stephan

In spite of the labor-saving methods and tables which are available, fitting parabolic trend lines to time series of any length is still a tedious process and the statistical computer is tempted to check only part of the calculations. This article presents a further development of accepted methods which saves time and labor in computation but which is especially designed to facilitate the proper checking of the whole process.[1]

The procedure here outlined is applicable to any series of points uniformly spaced along the horizontal scale, i.e., to any set of equidistant ordinates. It provides parabolic curves, fitted by least squares, of any desired degree up to the fifth: $Y=a+bx+cx^2+dx^3+ex^4+fx^5$. Curves of all lower degrees are secured as by-products. Its applicability to time series should give it a wide field of usefulness.

The advantages of the new procedure are several. It assigns the bulk of the work to the adding machine rather than to the calculator. The adding machine tape furnishes a quick and reliable check on this part of the computations. In the few remaining calculations, simple and direct formulas are substituted for the customary solution of "normal equations." Because of the directness of these calculations the computer can determine quite readily the number of significant figures to be retained. He can also tell at a glance approximately what the resultant values will be and thereby secure a rough but handy check on the latter part of the computations.

The quantities involved in the formulas are smaller, especially for an even number of ordinates, than those which are encountered in the usual methods. On the whole, the procedure requires fewer and simpler operations than the Doolittle Method, generally conceded to be the simplest of the well-known methods. The margin of advantage varies with the data and is greatest when a large and even number of ordinates is fitted with a parabola of third or higher degree.

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[1] Various phases of the methods here presented are to be found in the following references: R. W. Burgess, *Introduction to the Mathematics of Statistics*, 162–6 and 204–5; B. H. Camp, *The Mathematical Part of Elementary Statistics*, 106–8; H. T. Davis and V. V. Latshaw, "Formulas for the Fitting of Polynomials to Data by the Method of Least Squares," *Annals of Mathematics*, Second Series, 31 (1930), 52–78; W. P. Elderton, *Frequency Curves and Correlation*, 22–3; L. Isserlis, "Note on Chebysheff's Interpolation Formula," *Biometrika*, XIX (1927), 87–93; K. Pearson, *Tables for Statisticians and Biometricians*, xlvi–xlix and Table XXVII; E. C. Rhodes, "On the Fitting of Parabolic Curves to Statistical Data," *Journal of the Royal Statistical Society*, XCIII (1930), 569–573; Frank Ross, "Formulae for Facilitating Computations in Time Series Analysis," this Journal, XX (1925), 75–9; and E. T. Whitaker and G. Robinson, *The Calculus of Observations*, 201–7.

The procedure is actually less complicated than it first appears to a reader who is not familiar with summation methods. It consists of three stages, the adding machine work or "summation processes," the computation of the constants or parameters of the equation from formulas, and the determination of points on the curve from the equation. These stages will be described in order.

THE SUMMATION PROCESSES

The values to be derived from the data for use in the formulas are secured through repeated adding or summation. The summations start at each end of the Y-series and progress to its center. They can be performed very readily on any adding machine with a subtotal key. *Only as many steps should be taken in the following and later sections as are required by the degree of the curve being fitted.*

1. List the Y-values in the order of decreasing values of X. Let N be the number of Y-values in the series. Let P be $\frac{1}{2}N$ if N is even and $\frac{1}{2}(N-1)$ if N is odd. Determine N and P.

2. Starting with the first item (that which corresponds with the highest value of X) proceed to add the Y-series. Take a subtotal after each item, including the first. Continue until P items have been added. A series of subtotals is thus secured. Term this series the *upper first summation.*

3. Starting with the last item (that which corresponds to the lowest value of X) proceed to add the lower part of the Y-series in similar fashion but moving upwards. Term this series of subtotals the *lower first summation.*

4. Starting with the first subtotal of the upper first summation proceed to add the series of subtotals taking a new subtotal after each, including the first. This produces a new series of subtotals. Term it the *upper second summation.* In like manner summate the series of subtotals of the lower first summation.

5. Repeat this procedure using the new series of subtotals to obtain a third summation for each half of the data, summating the third series of subtotals to get a fourth summation, and so on. Continue until there are as many summations as there are parameters in the desired curve, e.g., for a cubic or third degree parabola, four summations of each half of the data are required.

A typical problem involving four summations is presented in Table I. A section of the adding machine tape for the third summation is also shown. Subtotals need not be taken during the last summation if a total is taken off at the proper point as explained below. Each summation should be checked before the next is performed.

TABLE I

BUSINESS FAILURES IN THE UNITED STATES, 1897–1921 *

Year	x	Number of failures Y	Summations First	Second	Third	Fourth
1921	+12	19,982	19,982	19,982	19,982	19,982
1920	+11	8,463	28,445	48,427	68,409	88,391
1919	+10	5,515	33,960	82,387	150,796	239,187
1918	+ 9	9,331	43,291	125,678	276,474	515,661
1917	+ 8	13,073	56,364	182,042	458,516	974,177
1916	+ 7	16,498	72,862	254,904	713,420	1,687,597
1915	+ 6	19,035	91,897	346,801	1,060,221	2,747,818
1914	+ 5	16,780	108,677	455,478	1,515,699	4,263,517
1913	+ 4	14,553	123,230	578,708	2,094,407	6,357,924
1912	+ 3	13,832	137,062	715,770	2,810,177	9,168,101
1911	+ 2	12,679	149,741	865,511	*3,675,688*	*12,843,789*
1910	+ 1	11,588	*161,329*	*1,026,840*	*4,702,528*	
1909	0	*11,872*				
1908	− 1	14,066	*128,757*	*838,756*	*3,988,384*	
1907	− 2	10,274	114,691	709,999	*3,149,628*	*11,228,277*
1906	− 3	9,385	104,417	595,308	2,439,629	8,078,649
1905	− 4	9,967	95,032	490,891	1,844,321	5,639,020
1904	− 5	10,417	85,065	395,859	1,353,430	3,794,699
1903	− 6	9,775	74,648	310,794	957,571	2,441,269
1902	− 7	9,973	64,873	236,146	646,777	1,483,698
1901	− 8	10,648	54,900	171,273	410,631	836,921
1900	− 9	9,912	44,252	116,373	239,358	426,290
1899	−10	9,642	34,340	72,121	122,985	186,932
1898	−11	11,615	24,698	37,781	50,864	63,947
1897	−12	13,083	13,083	13,083	13,083	13,083

* These data are taken from F. C. Mills, *Statistical Methods*, 284–290. By referring to Mills, the reader may compare the methods proposed here with the usual methods employed. Note that Mills does not show all the details of computation. Note also that if he had taken n to be even, the size of the numbers involved would have been increased considerably.

SECTION OF ADDING MACHINE TAPE FOR LOWER THIRD SUMMATION

```
 13,083 *

 13,083 S
 37,781

 50,864 S
 72,121

122,985 S
116,373

239,358 S
```

The results of the summations should be taken from the tapes for use in the formulas for the parameters of the curve.

If N is even, calculate T-values as follows:

T_1 is the sum of the Pth subtotals in the upper and lower first summations;

T_2 is the sum of the Pth and $(P-1)$th subtotals in the upper second summation *minus* the sum of the Pth and $(P-1)$th subtotals in the lower second summation;

T_3 is the sum of the $(P-1)$th subtotals in the upper and lower third summations;

T_4 is the sum of the $(P-1)$th and $(P-2)$th subtotals in the upper fourth summation *minus* the sum of the $(P-1)$th and $(P-2)$th subtotals in the lower fourth summation;

T_5 is the sum of the $(P-2)$th subtotals in the upper and lower fifth summations; and

T_6 is the sum of the $(P-2)$th and $(P-3)$th subtotals in the upper sixth summation *minus* the sum of the $(P-2)$th and $(P-3)$th subtotals in the lower sixth summation.

If N is odd, calculate T-values as follows:

T_1 is the sum of the Pth subtotals in the upper and lower first summation *plus* the central or $(P+1)$th item of the Y-series;

T_2 is the Pth subtotal in the upper second summation *minus* the Pth subtotal in the lower second summation;

T_3 is the sum of the Pth and $(P-1)$th subtotals in the upper third summation *plus* the sum of the Pth and $(P-1)$th subtotals in the lower third summation;

T_4 is the $(P-1)$th subtotal in the upper fourth summation *minus* the $(P-1)$th subtotal in the lower fourth summation;

T_5 is the sum of the $(P-1)$th and $(P-2)$th subtotals in the upper fifth summation *plus* the sum of the $(P-1)$th and $(P-2)$th subtotals in the lower fifth summation; and

T_6 is the $(P-2)$th subtotal in the upper sixth summation *minus* the $(P-2)$th subtotal in the lower sixth summation.

The procedure in making up these values may be illustrated from the data of Table I where the required subtotals are printed in italics.

		4,702,528	
161,320		3,075,088	
11,872	1,020,840	3,088,381	12,843,789
128,057	− 838,750	3,149,628	−11,228,277
$T_1 =$ 301,068	$T_2 =$ 188,084	$T_3 =$ 15,510,228	$T_4 =$ 1,615,512

If data for 1921 are excluded, making N even, the summations are altered. Table II shows the central portion of the new summation series. Values for the formulas now become:

	940,275		10,272,869
	787,056		7,128,637
128,757	− 838,750	3,143,932	−11,228,227
153,219	− 709,099	3,149,628	− 8,078,049
$T_1 =$ 281,976	$T_2 =$ 178,576	$T_3 =$ 6,293,560	$T_4 =$ − 1,905,120

These T-values with K-values taken from Table III are inserted in formulas for the calculation of the desired parameters.

TABLE II

BUSINESS FAILURES IN THE UNITED STATES, 1807–1020

Year	x	Number of failures Y	Summations			
			First	Second	Third	Fourth
1020	+11.5	8,403	8,403	8,403	8,403	8,403
1010..............	+10.5	5,515	13,078	22,441	30,004	30,307
....	....	....	....	....	....	....
1011..............	+ 2.5	12,670	120,750	645,700	2,350,876	*7,128,937*
1010..............	+ 1.5	11,588	141,347	*787,050*	*3,143,932*	*10,272,809*
1000..............	+ 0.5	11,872	*153,219*	*940,275*	....	....
1008..............	− 0.5	14,000	*128,757*	*898,750*	....	....
1007..............	− 1.5	10,274	114,691	*709,090*	*3,149,628*	*11,228,277*
1006..............	− 2.5	0,385	104,417	505,308	2,430,620	*8,079,649*
....	....	....	....	....	....	....

FORMULAS FOR THE PARAMETERS OF THE FITTED CURVE

If x is a value of the X variable measured in units of one interval between ordinates and from the midpoint between the first and last ordinates, if T-values are taken as defined above, and if K-values are derived from Table III, then the parameters of the curve $Y=a+bx+cx^2+. . . .$ fitted to the Y-series by least squares are as follows:[1]

Parameter	Formula	
	N is even	N is odd
a_1	$\frac{T_1}{N}$	$\frac{T_1}{N}$
$b_1=b_2$	$\frac{T_2}{K_1}$	$\frac{2T_2}{K_1}$
$c_2=c_3$	$\frac{6T_3-K_4T_1}{K_3}$	$\frac{3T_3-K_5T_1}{K_3}$
$d_3=d_4$	$\frac{10T_4-K_6T_2}{2{,}000{,}000K_7}$	$\frac{10T_4-(K_6-2)T_2}{1{,}000{,}000K_7}$
$e_4=e_5$	$\frac{280T_5+(K_6-3)\ (K_8T_1-20T_3)}{1{,}000{,}000K_9}$	$\frac{140T_5+(K_5-2)\ (K_8T_1-10T_3)}{1{,}000{,}000K_9}$
f_5	$\frac{504T_6-(7K_4-105)T_4+K_6(K_6-3)T_2}{2{,}000{,}000K_{10}}$	$\frac{504T_6-(7K_4-108)T_4+(K_5-2)\ (K_5-6)T_2}{1{,}000{,}000K_{10}}$

The subscript of each parameter indicates the degree of the curve in which it may be used. Calculate only those parameters required by curves of the degree desired and lower degrees. The remaining parameters of the desired curve are obtained from the parameters for curves of lower degree by the following formulas:

---

[1] Note that when N is even, the denominators for d_3 and f_5 are double those used when N is odd.

$$a_2=a_3=a_1-\frac{K_2c_2}{12};\qquad a_4=a_5=a_2+\frac{K_2}{40}\left[\frac{K_2-20}{14}e_4\right]$$

$$b_3=b_4=b_1-\frac{K_3d_3}{20};\qquad c_4=c_5=c_2-\left[\frac{K_2-20}{14}e_4\right]-e_4$$

$$b_5=b_3+5K_5f_5;\qquad d_5=d_3-\frac{(10K_4-80)f_5}{36}$$

Note that in calculating a_4 and c_4 the portion of each equation enclosed in brackets is common to the two equations and need be calculated but once.

The use of these formulas in computing the parameters of the fitted curve may be illustrated from the data of Table I. Assuming that five significant figures are needed:[1]

$$a_1=\frac{301,958}{25}=12,078\qquad b_1=b_2=\frac{2(188,084)}{2,600}=144.68$$

$$c_2=c_3=\frac{3(15,510,228)-156(301,958)}{101,460}=-3.4483$$

$$d_3=\frac{10(1,615,512)-154(188,084)}{3,052,120}=-3.5075$$

$$a_2=a_3=12,078-\frac{624}{12}(-3.448)=12,257$$

$$b_3=144.68-\frac{1,868}{20}(-3.5075)=472.28$$

The resulting curves and equations are:[2]

$$Y=12,078+144.68x$$
$$Y=12,257+144.68x-3.448x^2$$
$$Y=12,257+472.28x-3.448x^2-3.5075x^3$$

where x is "years since 1900" and Y is the number of failures in one year.

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[1] The difference between two quantities of nearly equal size is not accurate to as many significant figures as either of the original quantities. This source of inaccuracy, which should be watched in the numerators of the formulas, is equally but more subtly present in the solution of normal equations.

[2] It will be noted that these methods require the computation of parameters for all curves up to the degree of that sought. Hence the comparison of these curves of lower degree with the curve specifically being fitted is fostered and the selection of a curve of higher degree than necessary is discouraged.

The following formulas may be used to check the parameters as calculated from the formulas:

$$K_1\left(a_2+\frac{K_2c_2}{20}\right)=\begin{cases}4T_3+\frac{1}{2}T_1 & \text{(if } N \text{ is even)}\\ 2T_3 & \text{(if } N \text{ is odd)}\end{cases}$$

$$K_1\left(\frac{K_2b_3}{20}+\left[9K_3+\frac{K_4}{4}-\frac{1}{5}\right]d_3\right)=\begin{cases}6T_4+\frac{1}{4}T_2 & \text{(if } N \text{ is even)}\\ 12T_4+2T_2 & \text{(if } N \text{ is odd)}\end{cases}$$

$$2Na_4+K_1\left(c_4+\frac{K_2e_4}{20}\right)=2T_1$$

$$K_1\left(b_5+\frac{K_2d_5}{20}+\left[9K_3+\frac{K_4}{4}-\frac{1}{5}\right]f_5\right)=\begin{cases}T_2 & \text{(if } N \text{ is even)}\\ 2T_2 & \text{(if } N \text{ is odd)}\end{cases}$$

CALCULATION OF THEORETICAL Y-VALUES FROM THE FITTED CURVE

Points on the fitted curve corresponding to given x-values may be calculated by summation methods similar to those used in fitting the curve itself. Set up for summation a column the items of which are derived from the parameters of the curve as follows:

Item in column	Formulas for column entries	
	When N is even	When N is odd
First	$120f$	$120f$
Second	$24e-180f$	$24e-120f$
Third	$6d-24e+75f$	$6d-12e+30f$
Fourth	$2c-3d+5e-\frac{15}{2}f$	$2c+2e$
Fifth	$b+\frac{1}{4}d+\frac{1}{16}f$	$b+c+d+e+f$
Sixth	$a+\frac{1}{2}b+\frac{1}{4}c+\frac{1}{8}d+\frac{1}{16}e+\frac{1}{32}f$	$a+b+c+d+e+f$

Disregard any parameters which appear only in curves of higher degree than that fitted. The column will then contain as many entries not equal to zero as there are parameters in the curve. The first item will be $120f_5$ for a fifth degree curve, $24e_4$ for a fourth degree curve, $6d_3$ for a third degree curve, etc.

Summate the resulting column in exactly the same manner as the Y-series except that each summation is carried all the way down the column instead of stopping at the middle. Repeat the summations P times. The sixth or lowest line will then contain computed Y-values for $x=+\frac{1}{2}, +\frac{3}{2}, +\frac{5}{2}, \ldots\ldots +(P+\frac{1}{2})$, when N is even, and for $x=+1, +2, +3, +4, \ldots\ldots +P$, when N is odd.

These summations may well be performed on the adding machine. Negative items can be handled readily by the usual procedure of subtracting them from the next higher power of 10 and prefacing as many 9's as the keyboard will accommodate. Thus an item of -3.448 becomes 99,990.552 on an eight place machine. This number is then added in the summations as a positive number. *Due regard must be given to the position of the decimal point.*

To obtain computed Y-values for negative values of x, set up a second column like the first except that the signs of b, d and f are reversed in the formulas from which the items are calculated, and summate in the same manner as before. To check the summations calculate independently the Y-values for $x = +\frac{1}{2}(N-1)$ and for $x = -\frac{1}{2}(N-1)$.

If a large number of Y-values are to be computed it may be more convenient to carry the summation processes horizontally, adding horizontally line by line instead of vertically column by column. In either case the rule is that any item is the sum of the item immediately above it in the same column and the item immediately to the left of it on the same line.

TABLE III
CONSTANTS TO BE USED IN FORMULAS FOR PARAMETERS OF PARABOLIC CURVES

N	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	N
6	36	101	112	35		8	.000 108	2.295 040	.000 560	.000 240	6
7	56	140	252	48	12		.000 360	4.990 476	.005 280	.002 880	7
8	84	186	504	63		15	.000 990	9.350 595	.021 120	.018 720	8
9	120	236	924	80	20		.002 376	15.911 111	.068 640	.087 360	9
10	166	293	1 584	99		24	.005 148	25.279 167	.192 192	.327 600	10
11	220	356	2 574	120	30		.010 296	38.133 333	.480 463	1.048 320	11
12	286	425	4 004	143		35	.019 305	55.223 611	1.098 240	2.970 240	12
13	364	500	6 006	168	42		.034 320	77.371 429	2.333 760	7.637 760	13
14	455	581	8 736	195		48	.058 344	105.469 643	4.667 520	18.159 680	14
15	560	668	12 376	224	56		.095 472	140.462 540	8.868 288	40.310 400	15
16	680	761	17 156	255		63	.151 164	183.445 833	16.124 160	84.651 640	16
17	816	860	23 256	288	72		.232 560	235.466 667	28.217 280	169.303 680	17
18	969	965	31 008	323		80	.348 840	297.723 612	47.752 320	324.198 720	18
19	1 140	1 076	40 698	360	90		.511 632	371.466 667	78.450 240	599.074 560	19
20	1 330	1 193	52 668	399		99	.735 471	458.017 262	125.520 384	1 069.776 000	20
21	1 540	1 316	67 298	440	110		1.038 312	558.768 254	196.125 600	1 854.278 400	21
22	1 771	1 445	85 008	483		120	1.442 100	675.183 930	299.956 800	3 129.094 600	22
23	2 024	1 580	106 260	528	132		1.973 400	808.800 000	449.935 200	5 153.803 200	23
24	2 300	1 721	131 560	575		143	2.664 090	961.223 611	665.062 400	8 303.349 600	24
25	2 600	1 868	161 460	624	156		3.552 120	1 134.133 3	961.440 480	13 110.552 000	25
26	2 925	2 021	196 560	675		168	4.682 340	1 329.279 2	1 373.486 4	20 321.355 600	26
27	3 276	2 180	237 510	728	182		6.107 400	1 548.482 5	1 936.367 2	30 965.876 200	27
28	3 654	2 346	285 012	783		195	7.888 725	1 795.636 3	2 692.684 8	46 448.812 800	28
29	4 060	2 516	339 822	840	210		10.097 568	2 066.704 8	3 702.441 6	68 663.462 240	29
30	4 495	2 693	402 752	899		224	12.816 144	2 369.725 6	5 035.320 6	100 134.216 00	30
31	4 960	2 876	474 672	960	240		16.138 848	2 704.800 0	6 778.316 2	144 193.271 04	31
32	5 456	3 065	556 512	1 023		256	20.173 560	3 074.112 5	9 037.754 9	205 198.116 48	32
33	5 984	3 260	649 264	1 088	272		26.043 040	3 479.911 1	11 942.748	288 797.349 12	33
34	6 545	3 461	753 984	1 155		288	30.886 416	3 924.517 3	15 649.117	402 253.450 56	34
35	7 140	3 668	871 794	1 224	306		37.860 768	4 410.323 8	20 343.853	554 832.345 60	35
36	7 770	3 881	1 003 884	1 295		323	46.142 811	4 939.795 0	26 260.132	758 270.872 32	36
37	8 436	4 100	1 151 514	1 368	342		55.930 680	5 515.466 7	33 632.982	1 027 334.730	37
38	9 139	4 325	1 316 016	1 443		360	67.445 820	6 139.945 8	42 805.614	1 380 481.044	38
39	9 880	4 556	1 498 796	1 520	380		80.934 984	6 815.911 1	54 136.512	1 840 641.392	39
40	10 660	4 793	1 701 336	1 599		399	96.672 342	7 546.112 5	68 057.329	2 436 143.018	40

41	11 480	5 036	1 925 196	1 680	420		114.961 704	8 333.371 4	85 071.661	3 201 787.967	41
42	12 341	5 285	2 172 016	1 763		440	136.138 860	9 180.580 8	105 764.768	4 180 112.068	42
43	13 244	5 540	2 443 518	1 848	462		160.574 040	10 090.706	130 814.318	5 422 848.088	43
44	14 190	5 801	2 741 508	1 935		483	188.674 497	11 066.779	161 002.237	6 992 619.903	44
45	15 180	6 068	3 067 878	2 024	506		220.887 216	12 111.911	197 227.741	8 964 897.312	45
46	16 215	6 341	3 424 608	2 115		528	257.701 752	13 229.279	240 521.635	11 430 244.073	46
47	17 296	6 620	3 813 768	2 208	552		299.653 200	14 422.137	292 061.986	14 496 894.922	47
48	18 424	6 905	4 237 520	2 303		575	347.325 300	15 693.795	353 191.238	18 293 700.734	48
49	19 600	7 196	4 698 120	2 400	600		401.353 680	17 047.657	425 434.901	22 973 484.643	49
50	20 825	7 493	5 197 920	2 499		624	462.429 240	18 487.154	510 521.881	28 716 855.804	50
51	22 100	7 796	5 739 370	2 600	650		531.301 680	20 015.911	610 406.597	35 736 531.667	51
52	23 426	8 105	6 325 020	2 703		675	608.783 175	21 637.446	727 292.966	44 282 224.022	52
53	24 804	8 420	6 957 522	2 808	702		695.752 200	23 355.467	863 660.398	54 646 148.794	53
54	26 235	8 741	7 639 632	2 915		728	793.157 508	25 173.724	1 022 291.9	67 169 224.559	54
55	27 720	9 068	8 374 212	3 024	756		902.022 264	27 096.038	1 206 304.4	82 248 030.072	55
56	29 260	9 401	9 164 232	3 135		783	1 023.448 3	29 126.303	1 419 181.7	100 342 596.69	56
57	30 856	9 740	10 012 772	3 248	812		1 158.620 8	31 268.483	1 664 809.3	121 985 117.54	57
58	32 509	10 085	10 923 024	3 363		840	1 308.812 3	33 526.613	1 947 512.8	147 789 661.64	58
59	34 220	10 436	11 898 294	3 480	870		1 475.388 5	35 904.820	2 272 098.2	178 462 987.64	59
60	35 990	10 793	12 942 004	3 599		899	1 659.812 0	38 407.224	2 643 896.1	214 816 559.19	60
61	37 820	11 156	14 057 694	3 720	930		1 863.648 6	41 038.133	3 068 808.0	257 779 871.03	61
62	39 711	11 525	15 249 024	3 843		960	2 088.571 7	43 801.651	3 553 356.6	308 415 202.84	62
63	41 664	11 900	16 519 776	3 968	992		2 336.368 3	46 702.769	4 104 739.5	367 933 926.20	63
64	43 680	12 281	17 873 856	4 095		1 023	2 608.944 6	49 745.351	4 730 886.3	437 714 498.41	64
65	45 760	12 668	19 315 296	4 224	1 056		2 908.331 7	52 934.133	5 440 519.2	519 322 286.25	65
66	47 905	13 061	20 848 256	4 355		1 088	3 236.691 7	56 273.724	6 243 218.7	614 531 372.06	66
67	50 116	13 460	22 477 026	4 488	1 122		3 596.324 2	59 768.800	7 149 492.4	725 348 504.72	67
68	52 394	13 865	24 206 028	4 623		1 155	3 989.672 1	63 424.113	8 170 848.5	854 039 368.47	68
69	54 740	14 276	26 039 818	4 760	1 190		4 419.329 1	67 244.483	9 319 874.1	1 003 157 353.	69
70	57 155	14 693	27 983 088	4 899		1 224	4 888.045 8	71 234.303	10 610 318.2	1 175 575 024.	70
71	59 640	15 116	30 040 668	5 040	1 260		5 398.737 2	75 400.036	12 057 180.	1 374 518 489.	71
72	62 196	15 545	32 217 528	5 183		1 295	5 954.489 6	79 746.224	13 676 801.	1 603 604 904.	72
73	64 824	15 980	34 518 780	5 328	1 332		6 558.568 2	84 275.467	15 486 966.	1 866 883 321.	73
74	67 525	16 421	36 949 680	5 475		1 368	7 214.425 0	88 996.946	17 507 005.	2 168 879 152.	74
75	70 300	16 868	39 515 630	5 624	1 406		7 925.706 4	93 911.911	19 757 905.	2 514 642 495.	75
76	73 150	17 321	42 222 180	5 775		1 443	8 696.261 1	99 028.694	22 262 429.	2 909 800 602.	76
77	76 076	17 780	45 075 030	5 928	1 482		9 530.149 2	104 351.657	25 045 232.	3 360 614 780.	77
78	79 079	18 245	48 080 032	6 083		1 520	10 431.650	109 886.295	28 133 000.	3 874 042 038.	78
79	82 160	18 716	51 243 192	6 240	1 560		11 405.270	115 638.133	31 554 582.	4 457 801 797.	79
80	85 320	19 193	54 570 672	6 399		1 599	12 455.756	121 612.779	35 341 131.	5 120 448 010.	80

N	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	N
81	88 560	19 676	58 068 792	6 560	1 640		13 588.097	127 815.911	39 526 265.	5 871 447 061.	81
82	91 881	20 165	61 744 032	6 723		1 680	14 807.542	134 253.279	44 146 218.	6 721 261 756.	82
83	95 284	20 660	65 603 034	6 888	1 722		16 119.603	140 930.705	49 240 013.	7 681 442 007.	83
84	98 770	21 161	69 652 604	7 056		1 763	17 530.068	147 854.081	54 849 635.	6 764 722 290.	84
85	102 340	21 668	73 899 714	7 224	1 806		19 045.012	155 029.371	61 020 218.	9 985 126 659.	85
86	105 995	22 181	78 351 504	7 395		1 848	20 670.806	162 462.612	67 800 243.	11 368 081 575.	86
87	109 736	22 700	83 015 284	7 568	1 892		22 414.127	170 159.911	75 241 733.	12 900 637 098.	87
88	113 564	23 225	87 898 536	7 743		1 935	24 281.971	178 127.446	83 400 475.	14 631 096 952.	88
89	117 480	23 756	93 008 916	7 920	1 980		26 281.662	186 371.467	92 336 240.	16 570 157 994.	89
90	121 485	24 293	98 354 256	8 099		2 024	28 420.867	194 898.295	102 113 018.	18 740 059 636.	90
91	125 580	24 836	103 942 566	8 280	2 070		30 707.604	203 714.324	112 799 265.	21 165 243 824.	91
92	129 766	25 385	109 782 036	8 463		2 115	33 150.254	212 826.017	124 468 154.	23 872 426 174.	92
93	134 044	25 940	115 881 038	8 648	2 162		35 757.577	222 239.911	137 197 852.	26 890 778 908.	93
94	138 415	26 601	122 248 126	8 835		2 208	38 538.722	231 962.612	151 071 792.	30 252 126 272.	94
95	142 880	27 068	128 892 048	9 024	2 256		41 503.239	242 000.800	166 178 971.	33 991 153 114.	95
96	147 440	27 641	135 821 728	9 215		2 303	44 661.096	252 361.224	162 614 254.	38 145 627 384.	96
97	152 096	28 220	143 046 288	9 408	2 352		48 022.682	263 050.706	200 478 691.	42 756 637 288.	97
98	156 849	28 805	150 575 040	9 603		2 400	61 698.940	274 076.136	219 879 855.	47 868 843 920.	98
99	161 700	29 396	158 417 490	9 800	2 450		55 400.859	285 444.483	240 932 162.	53 530 750 190.	99
100	166 650	29 993	166 685 340	9 999		2 499	59 440.505	297 162.779	263 757 336.	59 794 986 914.	100

NOTE.—Each column of Table III except K_9 was set up by summation and checked at every tenth item by independent calculation. K_9 was calculated from K_7 and K_{10} separately thereby checking all three columns. The values of K_7, K_8, K_9 and K_{10} are given to at least eight significant figures which is adequate for most statistical work. If a greater number of places are desired they can be secured from K_3 by rather obvious multiplications.

The K-values represent the following functions of N:

$$K_1 = \frac{N(N^2-1)}{6}$$

$$K_2 = 3N^2-7$$

$$K_3 = \frac{N(N^2-1)(N^2-4)}{60}$$

$$K_4 = N^2-1$$

$$K_5 = \tfrac{1}{4}(N^2-1) \quad (N \text{ odd only})$$

$$K_6 = \tfrac{1}{4}(N^2-4) \quad (N \text{ even only})$$

$$K_7 = \frac{(N^2-9)}{28{,}000{,}000} K_3$$

$$K_8 = \frac{15N^4-230N^2+407}{5{,}040}$$

$$K_9 = \frac{(N^2-9)(N^2-16)}{63{,}000{,}000} K_3$$

$$K_{10} = \frac{(N^2-9)(N^2-16)(N^2-25)}{2{,}772{,}000{,}000} K_3$$

NOTES

THE TEST OF SIGNIFICANCE FOR THE CORRELATION COEFFICIENT: SOME FURTHER RESULTS

By Egon S. Pearson, *University of London*

In an earlier paper I have discussed the distribution of r in samples from non-normal populations in which $\rho=0$.[1] For the cases considered there, the population distributions for both x and y variables were taken to be the same, but it was suggested that it would be of interest to examine the position when x was drawn from one form of population and y from another. Further results of this character have now been obtained.

They consist of 3 series, drawn as follows,[2]

Series (a)	x	variable	from	population	(1)	($\beta_1=0.00$, $\beta_2=2.50$)
	y	"	"	"	(2)	($\beta_1=0.00$, $\beta_2=7.05$)
Series (b)	x	"	"	"	(1)	
	y	"	"	"	(4)	($\beta_1=0.99$, $\beta_2=3.83$)
Series (c)	x	"	"	"	(2)	
	y	"	"	"	(4)	

For each series there are 500 samples of 10 and 500 samples of 20. The experimental and normal-theory values of the frequency constants are compared in Table I. Since in each series at least one of the population distributions is symmetrical, the sampling distribution of r must be symmetrical, and any difference between B_1 and zero can only be due to sampling fluctuations. Observed values of B_1 and $\sqrt{B_1}$ have, however, been tabled as in the previous work. The agreement of σ_r and B_2 with the normal theory values is very close, except for samples

TABLE I

FREQUENCY CONSTANTS IN EXPERIMENTAL DISTRIBUTIONS OF r

Populations sampled	Samples of 10				Samples of 20			
	σ_r	B_1	$\sqrt{B_1}$	B_2	σ_r	B_1	$\sqrt{B_1}$	B_2
(1) and (2)	.3290	.014	−.117	2.465	.2276	.002	+.050	2.930
(1) and (4)	.3161	.000	−.009	2.350	.2260	.002	−.040	2.606
(2) and (4)	.3235	.001	−.024	2.619	.2260	.001	−.029	2.730
Normal theory values	.3333	0	0	2.455	.2294	0	0	2.714
Standard errors*	.0090		.074	.104	.0067		.088	.144

* Standard errors are those appropriate for 500 samples.

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[1] This Journal, June 1931, pp. 128–134.

[2] The population numbering is as in the earlier paper.

of 10, series (b); here the observed variation as measured by σ_r is too small by an amount approaching twice the standard error. This difference can also be traced in Table II.

TABLE II

EXPERIMENTAL SAMPLING DISTRIBUTIONS OF r WHEN $\rho=0$ (SAMPLES OF 10)

r	"Normal theory" frequencies	Populations sampled		
		(1) and (2)	(1) and (4)	(2) and (4)
00–05	54.6	57	47	50
05	53.7	55	58	51
10	52.1	54	45	54
15	49.8	57	57	47
20	46.9	38	58	50
25	43.2	37	47	54
30	39.1	44	44	51
35	34.7	30	29	34
40	30.1	21	35	20
45	25.3	24	27	10
50	20.8	28	14	20
55	16.5	20	17	18
60	12.3	11	10	8
65	8.0	11	5	7
70	5.8	3	4	8
75–80	3.0	1	2	3
Greater than 80	2.7	3	1	2
Totals	500.0	500	500	500
Goodness of fit	χ^2	13.30	15.55	14.80
	n'	16	16	16
	$P(\chi^2)$	0.58	0.41	0.47

TABLE III

EXPERIMENTAL SAMPLING DISTRIBUTIONS OF r WHEN $\rho=0$ (SAMPLES OF 20)

r	"Normal theory" frequencies	Populations sampled		
		(1) and (2)	(1) and (4)	(2) and (4)
00–03	50.0	47	52	43
03	49.2	47	49	51
06	47.9	60	46	50
09	45.7	42	41	38
12	43.3	37	54	57
15	40.1	38	32	34
18	36.7	44	34	42
21	33.0	29	32	43
24	29.3	29	34	25
27	25.4	29	26	23
30	21.7	21	28	21
33	18.2	19	20	15
36	14.9	15	15	20
39	12.0	10	10	11
42	9.4	11	6	7
45	7.1	10	5	6
48	5.3	4	5	4
51	3.8	2	5	1
54	2.6	4	..	3
57–60	1.8	1	4	2
Greater than 60	2.6	1	2	4
Totals	500.0	500	500	500
Goodness of fit	χ^2	16.60	13.99	17.35
	n'	19	19	19
	$P(\chi^2)$	0.61	0.80	0.56

The "doubled over" experimental distributions are compared with corresponding normal-theory frequencies in Tables II and III, and the result of applying the (P, χ^2) test for goodness of fit is shown. The agreement is remarkably satisfactory.

The adequacy of the fit for practical purposes may be illustrated as follows:

For $n=10$, normal-theory predicts that in 500 random samples from uncorrelated material we should expect to find 21.0 with $|r| \geq .65$. We find,

Series	(a)	(b)	(c)
Cases	18	12	20

Further, for $n=20$ we should expect in 500 samples, 23.2 with $|r| \geq .45$. We find,

Series	(a)	(b)	(c)
Cases	22	21	20

It will be noticed that in all cases there are *less* observed values beyond the limits, than theory predicts. The differences are, however, very small except in the one case $n=10$, series (b), for which the populations are, (1) platykurtic and (4) very skew. It is most probable that this last disagreement is not altogether a sampling fluctuation, but it will be seen that it is not repeated for $n=20$.

Taken with other results,[1] these figures again emphasize the insensitiveness of the sampling distribution of r to changes in population form.

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[1] For recent experiments in cases where ρ is not zero see, Chesire, Oldis and Pearson, this JOURNAL, June 1932, pp. 121–128; Paul Rider, a paper shortly to appear in *Biometrika*.

NOTE ON AGE AT TIME OF MARRIAGE IN TWO MEXICAN LOCALITIES OF DIVERGENT TYPES

By Paul S. Taylor, *University of California*

Studies of age at time of marriage bear specifically upon rate of population growth and reveal, as well, customs of general social importance. This note presents the results of recent researches in ecclesiastical archives of two localities in Mexico, a country in which reliable population data have been distressingly meagre.

Arandas is a *municipio* (county) in Los Altos of Jalisco, central Mexico, a region inhabited by small peasant proprietors, probably about 85 per cent of whose collective ancestry is Spanish. Its people are strongly anti-*agrarista* and ardently Catholic; they furnished the bulwark of the powerful Cristero revolution against the Mexican government from 1926 to 1929. The region has been, and continues to be, a source of rapid population increase. According to the census of 1930, its population was 27,624, of whom 7,574 lived in the town of Arandas, the only really important population center in the municipio.

San José Tateposco, Jalisco, is a small *pueblo* (village) a few miles distant from Guadalajara. Its inhabitants, who numbered 441 in 1930, are collectively about 85 per cent of Indian stock. Their traditional and contemporary occupations have been the making of pottery, and agriculture; the agricultural activities are limited to cultivation of very small plots, and day labor on the adjoining hacienda. Catholicism is universally accepted, but in recent years the formation of a *comunidád agrária* by many of its inhabitants who have obtained lands from the hacienda under the agrarian law, has thrown their allegiance to the side of the government rather than to the Cristeros.

Railways and good highways penetrate neither Tateposco nor Arandas; both are physically and socially isolated. Marriages of the Tateposqueños have been, and continue to be, almost universally with persons of the same village. The comparatively few marriages in Arandas involving one party from outside the municipio have practically always been contracted with persons from other parts of Los Altos, a region which is homogeneous. In Arandas there are persons of small town and rural middle-class, a type which is absent from Tateposco.

Data on age at time of marriage which practically bracket a century are presented in the accompanying table. The actual selection of the samples in each of the localities was influenced largely by the availabil-

TABLE 1

COMPARISON OF CHANGES DURING THE PAST CENTURY IN AGE AT TIME OF MARRIAGE IN ARANDAS AND IN SAN JOSÉ TATEPOSCO, JALISCO, MEXICO, AS SHOWN BY SAMPLE GROUPS OF 100 COUPLES EACH*

Age	Number								Cumulative Total							
	Men				Women				Men				Women			
	Arandas		Tateposco		Arandas		Tateposco		Arandas		Tateposco		Arandas		Tateposco	
	1825–6	1930	1831–65	1902–32	1825–6	1930	1831–65	1902–32	1825–6	1930	1831–65	1902–32	1825–6	1930	1831–65	1902–32
12	. .	. .	. .	. .	1	. .	2	. .	. .	. .	. .	. .	1	. .	2	. .
13	. .	. .	. .	. .	. .	. .	1	. .	. .	. .	. .	. .	1	. .	3	. .
14	. .	. .	. .	. .	4	1	12	. .	. .	. .	. .	. .	5	1	15	. .
15	2	. .	3	. .	21	10	30	19	2	. .	3	. .	26	11	45	19
16	2	. .	7	. .	24	7	22	23	4	. .	10	. .	50	18	67	42
17	3	1	7	1	9	17	13	10	7	1	17	1	59	35	80	52
18	13	2	25	8	14	16	13	26	20	3	42	9	73	51	93	78
19	11	6	9	11	12	10	3	9	31	9	51	20	85	61	96	87
20	18	7	24	29	5	5	1	4	49	16	75	49	90	66	97	91
21	6	9	5	10	2	5	1	1	55	25	80	59	92	71	98	92
22	12	16	2	21	5	14	. .	4	67	41	82	80	97	85	98	96
23	7	12	2	6	. .	2	. .	2	74	53	84	86	97	87	98	98
24	2	11	4	6	. .	2	. .	. .	76	64	88	92	97	89	98	98
25	10	9	8	4	1	4	1	1	86	73	96	96	98	93	99	99
26	3	6	1	. .	. .	3	. .	. .	89	79	97	96	98	96	99	99
27	4	4	1	1	. .	1	1	. .	93	83	98	97	98	97	100	99
28	. .	4	. .	2	. .	. .	. .	1	93	87	98	99	98	97	100	100
29	. .	2	. .	. .	. .	1	. .	. .	93	89	98	99	98	98	100	100
30	2	4	1	1	1	2	. .	. .	95	93	99	100	99	100	100	100
Above 30	5†	7‡	1¶	. .	1§	. .	. .	. .	100†	100‡	100¶	100	100§	100	100	100

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* Data from *Registro de matrimonio*, Arandas, and Tonalá, respectively. See text for description of method of obtaining sample groups.

† One person each, aged 35, 41, and 44; two persons aged 32.

‡ One person each, aged 32, 33, and 34; two persons each, aged 35 and 39.

¶ Aged 33.

§ Aged 40.

ity of data in the respective archives. Though not obtained in identical manner in the two localities, they are nevertheless believed to be comparable for the purposes of this note. The Arandas samples include the first one hundred first-marriages (i.e., excluding widowers and widows) during the years indicated in the table. The Tateposco samples represent all first-marriages from January 7, 1831, to May 22, 1865, and from May 15, 1902, to July 13, 1932, respectively. The smallness of the Tateposco population practically compelled this method; observation of the records year by year while compiling the table leads to the conclusion that no important distortion, or concealment of trends, has resulted. Ecclesiastical registration has been really effective in both localities throughout the period under review.

It will be noted upon examination of the data in the table that the age of marriage of both men and women is markedly earlier in Tateposco than in Arandas, both historically and contemporaneously. Thus in the first period, 55 per cent of the Arandas men and 80 per cent of the Tateposco men married when under 22 years of age. In the contemporary period, the comparable figures were 25 per cent and 59 per cent, respectively. Among the women, 85 per cent of those from Arandas and 96 per cent of those from Tateposco married when under 20 years of age, during the first period. In the contemporary period, the comparable figures were 61 per cent and 87 per cent, respectively.

So far as age at time of marriage is concerned, in both these rural, isolated, separated, Catholic communities—the one "Spanish" and peasant proprietor, the other "Indian" and potter and agricultural laborer—the tendency has been notably toward the operation of this preventive Malthusian check to population increase, but the tendency has been more marked in the former than in the latter. In Arandas the advance in age was more marked among men than among women. Thus, for example, the percentage of Arandas men who married when under 21 years of age fell from 49 to 16, and the percentage of Tateposco men fell from 75 to 49, during the period under review. The percentage of Arandas women who married when under 19 years of age fell from 73 to 51, and the percentage of Tateposco women dropped from 93 to 78. Other comparisons may be made by consulting the table.

The differences and changes in age at time of marriage, as shown by median and mean ages, are as in Table II.

Thus the mean age at time of marriage of Arandas men advanced 2.1 years (median 2.6) while the mean age of Arandas women advanced 1.4 years (median 1.2). The mean age of Tateposco men advanced

1.4 years (median 1.2) and the mean age of women advanced 1.4 years (median 1.6).

TABLE II

Age	Men				Women			
	Aranda		Talepaoeu		Aranda		Talepaoeu	
	1825-6	1930	1831-65	1902-32	1825-6	1930	1831-65	1902-32
Median	21.2	23.8	19.9	21.1	17.0	18.9	16.2	17.8
Mean	22.0	24.1	19.8	21.2	17.5	19.4	16.1	17.5

ERRATA

Two corrections should be made in the article by Edward V. Huntington, "An Improved Equal-Frequency Map of the Normal Correlation Surface, Using Circles Instead of Ellipses," in the September, 1932, issue of this JOURNAL:

Page 255, last line, for ρ read p:

Page 255, third line from bottom, for s read e.

THE OUTLOOK FOR THE PRICE LEVEL

A dinner meeting of the American Statistical Association was held on Thursday evening, September 29, 1932, at the Hotel Empire, Broadway and 63rd Street, New York City. One hundred forty-seven persons were present. The President of the Association, Irving Fisher, was in the chair. The general topic for discussion was, *The Outlook for the Price Level.*

The first speaker of the evening was Lionel D. Edie, President of the Capital Research Company. His subject was "The Effect of the Federal Reserve Policy." He began by stating that the event of greatest importance to the people of the United States in 1932 was the halting of the deflation movement which had continued since 1929. He expressed the opinion that it was the passage of the Goldsborough Bill through the House and the threat of enactment of the Patman Bill which precipitated action by the Federal Reserve authorities.

The main force which stopped the downward trend of wholesale commodity prices was the purchase of large quantities of government bonds by the Federal Reserve Banks. Since prices continued to decline for some time after the policy of rapid purchasing was begun, many believed that the open market activity of the Federal Reserve system was not responsible for checking the downward movement. As a matter of fact, however, a lag was to be expected, for, in previous instances, a considerable period had elapsed between the time of Federal Reserve action and the resultant effect upon the price level.

The recent upturn of prices has been aided by the natural speculative rebound following a period of abnormally low prices in basic commodities. This rebound is partly to be explained by short covering and partly by the fact that, as soon as buyers feel that prices are not going lower, they are ready to enter the market. As yet, the large surpluses of raw materials accumulating during the period of depression have not been dissipated, but they appear to have reached a point where they are not increasing further and, in respect to certain commodities, they have shown declines.

Since there has, as yet, been no marked increase in the supply either of currency or of deposits subject to check there is, at present, little reason to expect any marked rise in commodity prices. If, however, the present policy of the Federal Reserve Banks is maintained, it is unlikely that the price decline will be resumed.

It is hard to over-estimate the importance of the demonstration which we have had of the ability of central banks to arrest violent price movements. It will be a great misfortune if, in the future, this lesson is overlooked, forgotten, or ignored.

At present, we are confronted by two dangers:

1. The Federal Reserve Banks may yield to the pressure of certain influential groups and prematurely begin selling the government bonds which they now hold in their portfolios. Should they do this soon, it is almost certain that incipient recovery would be either seriously retarded or entirely overcome.

2. The reserves of member banks may be increased further by gold inflow and by return flow of currency. If, as time passes, optimism returns and loans multiply unduly at the member banks, the Federal Reserve Banks may hesitate too long before attempting to put on the brakes.

Dr. Edie closed by stating that he considered it probable that, during the next six months, the price level will not increase by a percentage greater than the increase in the volume of business activity.

At the close of Dr. Edie's paper, the Chairman remarked that reports from Sweden indicate that, for more than a year now, prices have been almost completely stabilized through central bank action. Sweden, being off the gold standard and employing a managed currency, can readily stabilize prices.

The second speaker of the evening was Professor F. A. Pearson of Cornell University who discussed "The Relation of Gold to Prices." He illustrated his remarks by aid of a considerable number of charts. Professor Pearson pointed out that the world physical volume of production has, for a long time, tended to increase at a compound rate of about 3.15 per cent a year, or 1.91 per cent per year, when reduced to a per capita basis. During, and after, the World War, however, these rates fell off sharply, and not until 1927 did world production get back to its normal trend. While physical production of other commodities tends to move along a straight line on a ratio chart, the production of gold proceeds in huge waves. One such wave reached its peak in the early 50's; the next wave crest was just before the World War, and the third high wave has very recently been starting its development. Between 1850 and 1914, the index of wholesale prices in England paralleled very closely the ratio of world gold stocks to world physical production of commodities. Between the beginning of the World War and 1929, the wholesale price level, both in England and the United States, was far above the index representing this ratio. At present, however, it has fallen below this index. It appears, therefore, that while, in the long run, the price level is dependent almost entirely upon the ratio of world gold supply to world production, there are many short-time discrepancies due to business cycles and other causes.

Fifty-six per cent of the world's gold production during the last eighty years has been added to monetary stocks. During a period when gold production is low, the percentage added to monetary stocks declines. This percentage is also affected by business cycles. There seems to be no tendency for a permanent change in the long-time trend.

It is necessary that monetary stocks increase 3.15 per cent per year in order to maintain stable commodity prices. To provide for this increase and the normal amount used in the arts, the annual gold production must be 5.6 per cent of monetary stocks. Whenever gold production is below this rate, the trend of prices tends to be downward. High or low production changes but slightly the stocks of gold on hand. Therefore, price changes lag after gold production. For the United States, the best fit is found with a lag of about 13 years. The amount of this lag is accidental, for it depends upon the rate of gold production. If a gold supply equal to existing monetary stocks were mined in a single year and added to the stocks, prices would probably double in the following year.

Available statistics indicate that, in the United States, if stable prices are to be maintained, credit must increase materially faster than production and the gold supply.

Professor Pearson concluded by showing an interesting comparison between a demand curve for gold and a demand curve for corn. His figures indicated that these two curves are very similar in shape. He stated, also, that the demand curves for wheat, oats, hay and cattle, closely resemble those for gold and corn. A study of these demand curves shows that, when the supply of gold is 20 per cent below normal, the value of gold is 23 per cent above normal. When the supply of gold is 20 per cent above normal, its purchasing power is 15 per cent below normal.

The third speaker of the evening was Professor George F. Warren, also of the Department of Agricultural Economics of Cornell University. He discussed the future of the general price level. Professor Warren began by reading from a bulletin published in 1922 and in which he discussed the probable future of commodity prices. At that time, he pointed out that, when European nations decided to return to gold bases, they would draw gold to Europe and prices would tend to fall toward the pre-war level. He also showed that the lowered value of gold, brought about by the War, would tend to diminish the volume of gold production. As everyone knows, both of these forecasts have been amply verified by the facts.

A question which has bothered economists is why prices, measured in gold, rose so greatly between 1914 and 1920. In Dr. Warren's opinion, part of this rise was due to reduced use of gold by many countries and part was caused by the fact that so much of the trade of the world was being conducted by governments and, hence, there was little demand for money, and especially for gold, in carrying on this trade. Prices fell in the period 1920–1921 when business returned to private hands.

The recent downward tendency in prices, as measured in gold, has been brought about by the great scramble for gold reserves caused by the European nations returning to the gold standard. Just now, many countries have gone off the gold standard again, but most of them are still contemplating returning to it and hence are anxious to continue accumulating gold.

At present, prices are somewhat below the trend indicated by the relationship of gold to normal production. The trend indicates that the price level should return to approximately its pre-war altitude. This does not mean a large advance for most prices. However, the prices of many farm products have recently averaged only about half of what they were before the World War. There is, then, plenty of room for a sharp improvement in these prices. The gold supply of the world today is sufficient to maintain prices somewhat higher than those predominating before the World War, but this condition cannot be expected to continue if production and business activity return to normal. The present volume of gold production is only about three-quarters of the normal requirements. With the present gold production, and all the world on a gold basis, we should expect prices to decline about 1 per cent per annum.

One feature of the present situation is decidedly unfavorable. We are attempting to adjust ourselves to a lowered price level. This means that we are under the necessity of liquidating debts incurred at a higher price level. The chances are that the burden of these debts will tend, for some time to come, to prevent the development of real prosperity. We are, therefore, at present, victims of the radical policy of attempting to liquidate debts incurred in the past. The more conservative policy would have been to adjust our price level upward to the plane which it occupied when the debts were incurred. This would have been a more conservative procedure, even if it had necessitated changing the weight of gold in the dollar.

The fourth regular speaker was Mr. Frederick R. Ottman of the Economics Department, New York University, who spoke on the subject, "Probable Changes in the Velocity of Circulation." He presented charts showing the relationship between the velocity of circulation of bank deposits, the volume of trade, and the price level. He pointed out that the velocity of circulation of bank deposits in New York City fluctuates through a wider amplitude than does the velocity of deposits in banks outside of the metropolis. A study of the figures which are now available for something like a decade, does not indicate that there is any close correlation between the velocity of circulation of bank deposits and the general price level. In a number of instances, the indications are that price movements have anticipated changes in velocity. Under these circumstances, it does not seem probable that velocity can correctly be assumed to be a causal factor as regards price changes.

The fact, however, should not be overlooked that, during the period when security prices were rising very rapidly, there was no corresponding increase in the volume of money or bank deposits, subject to check. During this period, the equation of exchange was balanced primarily by an increase in the velocity of circulation. Had such an increase in velocity not been possible, it might well have been true that security prices could not have risen as they did.

All the evidence indicates that changes in velocity are closely coupled with changes in the volume of trade. At present, the velocity of circulation of bank deposits is far below normal and so is the volume of trade. Both may be expected to increase together at about the same rate. There is, therefore, no reason for believing that this anticipated increase in velocity will tend to cause a rise in the price level.

The discussion from the floor was opened by Emile Despres of the Federal Reserve Bank in New York. He raised several questions concerning the arguments advanced by Professors Warren and Pearson. The first of these questions was whether the price level was not governed primarily by the extent of the reserves found in the central banks rather than by the total stock of gold in the world. He pointed out that the stocks of gold in the world's central banks and treasuries have apparently increased sufficiently to keep prices at a level 50 per cent above pre-war. Mr. Despres could see no reason why the ratio of credit to gold might not be expanded, thus lifting the price level still further without any increase in the supply of gold. He also felt that Professor Warren erred both in taking the prices of commodities at wholesale as a criterion of the general price level, and in using production of basic materials as a criterion of the volume of trade. He pointed out that production of such commodities has not been increasing as fast as the volume of trade.

Professor Warren replied to Mr. Despres by stating that what he was attempting to measure was the relationship between the gold supply and the prices of commodities at wholesale. He agreed fully with Mr. Despres that there is, at present, more trade per unit of basic commodities produced than was formerly true and he stated that it was because of this fact that credit must increase faster than the volume of physical production of basic commodities, if a steady price level is to be maintained.

Professor Warren stated that Mr. Despres' belief that it was possible to expand materially the ratio of credit (including paper currency) to gold is not borne out by the experience of the past. In several instances, such an expansion has taken place, but each time a crash has resulted. It appears, then, that the relationship between the volume of credit plus currency and the gold supply does not have a sharply upward trend but rather one which is very slowly upward, and that departure from this trend is fraught with no little danger to business. Dr. Warren also held that Mr. Despres overlooked the fact that gold is a commodity and that its value is governed by the same law governing the value of other commodities.

By superimposing upon a gold basis a large volume of credit, prices may be temporarily forced upward but, when prices rise, a business reaction is probable. The attempt, therefore, to use expansion of credit to maintain a higher level of prices than is warranted by the stock of gold is doomed to failure. If it were possible to do this, gold production would be discouraged.

Dr. Warren pointed out that many economists overlook the fact that the world is still on its way toward a gold basis. India is approaching a full gold standard and China and South America are looking in that direction. We have, therefore, in prospect an increasing demand upon the gold stocks of the world.

Dr. W. W. Cumberland asked two questions of Dr. Edie:

1. How far could the Federal Reserve Banks proceed in their program of buying government securities without destroying confidence and reaching the limits of their reserves? Might it not well have happened that this point would have been reached before they succeeded in stopping the price level decline? If so, what could they have done about it?

2. If, in the future, prices should begin to rise rapidly, and, in an endeavor to stop such a rise, the Federal Reserve Banks should sell out all their holdings of government securities, but prices should still move upward, what could the Federal Reserve Banks then do?

Dr. Edie made no definite response to the first question but, in answer to the second, said that the Federal Reserve Banks could put pressure upon the member banks to hold down their volumes of loans and, in this manner, tend to head off a period of inflation. He admitted, however, that it was possible that the Federal Reserve Banks might lose control of the situation, despite their best endeavors.

WILLFORD I. KING, *Secretary*

PROGRESS OF WORK IN THE CENSUS BUREAU

The three-year period allowed by law for the completion of the reports of the Fifteenth Census ends on December 31; and the temporary force, numbering at this date (November 1) about 630, as compared with a maximum of 6,022 reached on November 1, 1930, will have to be discharged before the appropriation for that census becomes exhausted. But if, happily, there should be any unexpended balance on December 31, a clause in the appropriation Act makes it legitimate to use it for Fifteenth Census work continued beyond that date; and there is a hope that under this provision of the law some small sum may be available for continuing work on census studies or monographs. All the copy for the thirty-two main volumes of Census reports has already been forwarded to the printer; nine volumes have been printed; and all or nearly all the remaining volumes should be printed by the end of the year.

On January 1, then, the Bureau will go back to the regular basis of organization with a permanent force of about 730 employees; and its work for the following six months must be carried on under its appropriation for the fiscal year 1932-1933, which, by the way, is about 27 per cent below the amount asked for in the estimates. This reduction was demanded by the program of government economy, being a part of the general reduction of government expenditures made with a view to balancing the budget. While this limitation in the funds available for the Bureau will involve some curtailments in the work as originally planned, it will not mean the abandonment of any field of statistical inquiry regularly covered by the Bureau in the year following the completion of the decennial census. The Bureau will get out its regular annual reports on deaths and births, on marriages and divorces, and on financial statistics of states and cities; and will organize and carry on the other periodical inquiries which under the ten-year program of census work are due at this time. These include the decennial inquiry on wealth, public debt, and taxation, and that on institutional classes, the quinquennial inquiry on electrical industries, and the biennial census of manufactures.

Biennial Census of Manufactures.—Work on the biennial census of manufactures is practically continuous, as the work on one census begins before that on the preceding census is ended. The census of manufactures covering the year 1929 was taken and published as a part of the Fifteenth Census of the United States, thus superseding or replacing the biennial census that was due for that year. The results will be published in three volumes of Fifteenth Census reports. In one of these the statistics are assembled by states, in another by industries, and in a third—the general report—by subjects. The collection of data for the biennial census covering the year 1931 has been finished, and the publication of the preliminary results by industries, in the form of press releases, is nearing completion.

Report on National Wealth, Public Debt, and Taxation.—Under the law establishing the permanent census, enacted in 1902, the Director of the Census is authorized to collect decennially statistics relating to "public indebtedness, valuation, taxation, and expenditures"; and this compilation has been regularly made for the second year following the decennial census year, beginning with the year 1902.

The statistics for the present inquiry will be collected and presented under three main divisions: (1) Public receipts and payments; (2) public indebtedness; and (3) assessed valuations and tax levies.

For 1922 no statistics in regard to payments were secured other than those regularly obtained for the annual reports on financial statistics of states and of cities of over 30,000; and for 1912 the statistics of payments as compiled in the decennial inquiry did not go beyond those for states, counties, and cities of over 2,500 population. This time it is proposed to obtain statistics in more or less detail covering payments for all states, cities, counties, and other civil divisions.

The payments will be classified with respect to purpose under the following heads: (1) General government; (2) protection to person and property; (3) health and sanitation; (4) highways; (5) charities, hospitals, and corrections; (6) schools; (7) libraries; (8) recreation; (9) miscellaneous; (10) public service enterprises; (11) interest; (12) payments on account of debt obligations.

This classification will be shown in full for all state and county governments and all cities so far as possible; but for the smaller cities and minor civil divisions it will not be practicable to obtain all this detail, and a condensed classification will be used distinguishing simply expenditures for (1) all general departments; (2) public service enterprises; (3) interest; and (4) debt obligations. Outlay payments for permanent improvements will be separately shown.

There will be an equally detailed classification of receipts, distinguishing the general property taxes; special taxes, subdivided as (a) inheritance, (b) income, and (c) all other; poll taxes; licenses and permits; special assessments; and certain other specific sources of revenue.

To a large extent it will be possible to secure the required data from reports on file at the state capitals. There are in fact 16 states which require all minor civil divisions to make reports to some state department. The list comprises Arkansas, California, Indiana, Iowa, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, Washington, West Virginia, and Wisconsin. These states have adopted in the main the classification of receipts and payments applied by the Bureau of the Census in its annual reports on financial statistics of states and cities, and therefore the detail that is desired will be readily available. There are 16 other states which have data at the state capitals for county governments and for some other civil divisions. The remaining 16 states have practically nothing available at the state capitals except statistics on assessed valuations and tax levies and on schools.

The data not available at the state capitals will be secured by a mail canvass. Local agents at the state capitals are now compiling all the data there available;

and the mail canvass is in progress and will be completed during this calendar year. This method of collection will represent a material saving in expense as compared with the method followed ten years ago, when there were only a few states for which any data other than those relating to the state governments were available at state capitals, and in order to obtain the statistics agents of the Bureau visited practically every county in the United States.

Included with this inquiry, although not organically connected with it, is the census estimate of National wealth, which has been made in connection with or following each decennial census beginning with that of 1850. From 1850 to 1870, inclusive, the figures covered simply the true value of taxable property, both real and personal, as estimated upon the basis of the assessed valuation and reported for counties by the assistant marshals, who were the census enumerators of those days; and the figures as published by states were probably simply a summation of these reports for the counties. But in the more recent censuses the estimates have been made centrally at the Bureau in Washington; and while the estimate of the value of real property is in large part based upon the assessed valuation of real estate as reported in the census of taxation, other data derived from the censuses of agriculture, manufactures, and electrical industries, and from other sources are used in estimating other forms of property. The estimate of wealth must wait upon the results of the census of taxation for some of the basic data, and no definite plans regarding it have been formulated as yet.

Census of Institutional Classes. This is another inquiry provided for in the permanent Census Act of 1902, which authorized the Director to collect decennially statistics relating to "the defective, dependent, and delinquent classes," with the proviso that these statistics should be restricted to institutions containing such classes, which proviso was not, however, retained in a later revision of that section of the law. The census, however, continues to be limited to institutional classes. For 1922 it covered sentenced prisoners in prisons, reformatories, jails, and other penal institutions; patients in hospitals for mental disease; inmates of institutions for the feeble-minded and epileptic; paupers in almshouses; and children under institutional care. It included also statistics regarding hospitals and dispensaries. As the plans for the next census are still more or less in the formative stage, a report on this subject may best be presented in a later issue of this JOURNAL.

J. A. H.

MISCELLANEOUS NOTES

Committee on Governmental Labor Statistics.—Since its last report, the Committee's study of Statistical Procedure in Public Employment Offices has been completed for publication by the Russell Sage Foundation. It is published for the Committee as a companion volume to *Employment Statistics for the United States,* which contains the Committee's recommendations for governmental statistics of employment and unemployment. The forthcoming study is closely related in that it sets up a plan for making the administrative material of public employment offices available as a measure of demand and supply in the labor market. It describes in detail the statistical procedures of public employment offices in Great Britain, Germany, France, Switzerland, Sweden, Canada and the United States, based on field work in those countries, and suggests standard procedure for public employment offices in the United States. Experimentation with this procedure is already under way in the public employment office demonstration centers at Rochester, Philadelphia and Minneapolis, and conferences with representatives of the centers have been held concerning installation of the procedure and possible short cuts in its use.

In general it can be said that the plan is meeting the test of actual use quite well. While a number of suggestions for reducing the clerical work it involves have been received, all of these would make it impossible to identify the individual transactions in the statistical totals, one of the principal features of the suggested procedure. Employment office executives present at the conferences have insisted that this identification principle should be retained so that fraudulent returns of placements may not be made by local offices and that inspection of the offices may be more effective. It has also been revealed that the procedure does not involve more clerical work than some of the reporting systems now in use.

The recommendations of the study were presented to the International Association of Public Employment Services at its recent annual meeting in Washington. If, as may be anticipated, legislation both in Congress and in the states results in more adequate development of a national public employment service in the United States, this study will be ready as a handbook of practical suggestions and a basis for uniformity in statistical and administrative measurements.

The Cleveland Chapter.—The Business Statistical Group of the Cleveland Chapter held its first meeting of the season on Monday, September 26.

Mr. D. A. Hill of the Ohio Public Service Corporation, Vice-President of the local Chapter, will act as Chairman for the coming year. Mr. E. A. Stephen, Secretary of the Chapter, will continue as Secretary for the Business Group.

The meeting was devoted to a forecast of the Annalist index of business activity for the coming year.

The Chapter regretted to learn of the death of one of its most active members, Mr. R. H. Hammond of the White Motor Company.

The Los Angeles Chapter.—A meeting of the Los Angeles Chapter was held on April 27, the speaker of the evening being Mr. Eugene Rittenhouse, a stock market analyst of some twenty years' experience. Mr. Rittenhouse spoke on the probable trend of the stock market, basing his prognostications on the various movements of the Dow-Jones Index of industrial stocks. It was his contention that the stock market acts in long-time swings of accumulation and distribution lasting about thirty to forty years in length. He maintains that the panics of 1907, 1915 and 1921 were merely minor movements of the accumulation process and that the distribution of stocks to the general public did not begin until about 1928, ending, of course, in the debacle of 1929. The movement of the stock market since that time he described as being the preliminary movement of another period of accumulation which, it is expected, will cover the coming generation. From his calculations he estimated that the Dow-Jones Index would reach a level of approximately 37.5 by May, 1932, the lowest point for many years to come. It was his further contention that late in June or early in July an inflationary movement of considerable magnitude would come with the result the Dow-Jones Index would reach approximately 185 by the first of November, 1932. This would be followed by a decline in the market until the summer of 1933, when the market should reach a level of approximately 85 on the Dow-Jones

Index. He further stated he expected that sometime in 1935 the market will reach a level of better than 300.

The next meeting of the Los Angeles Chapter was held August 23, the principal speaker being Dr. Ray B. Westerfield, Professor of Political Economy at Yale University. The subject was "The Necessary Shift in Basic Banking Philosophy." Dr. Westerfield spoke at some length on the very large number of banking failures in this country during the past few years, which he believed was largely due to the existing system of banking. He brought out that when this country was in the pioneer stage of development this system was effective because of the isolation of the various communities, one from another. In recent times, however, the economic structure of our country has passed beyond this pioneer stage and has become more complex.

Because of this complexity it has become impossible for any individual, such as the country banker, to be informed on the proper handling of any financial matters. Also because of the conservative nature of both banking and rural thought, the country banker has not progressed in his practices to meet the needs of his community. It was Dr. Westerfield's belief that these needs of the country are best filled by an organized banking structure, such as the existing system of branch banking. This is evident by the situation in California where, with two large branch banking systems, California has the lowest rate of bank failures of any state in the Union. With such managerial ability as can be brought together by large banks the various problems concerning the operation of the banks may be met most advantageously.

The Pittsburgh Chapter.—Mr. Joseph P. Tufts, Assistant Director of the Pittsburgh Housing Association, gave an interesting discussion at the meeting, on August 25, on the "Probable Effect of the Home Loan Bank Act." There was the lowest attendance of the year, 16, largely due to vacations.

At the September meeting on September 22, Mr. C. R. Texter, Chief of the Bureau of Information for the Greater Pennsylvania Council, gave an interesting discussion on "Population Trends, 1900 to 1930, and Their Effect on Industrial Development." About 35 attended.

United States Bureau of Labor Statistics.—An investigation of the effects of technological changes upon employment in the manufacture of electric light bulbs is now being made by the Bureau. Reports on similar studies for the electric light and power industry, mail transportation, and the leather industry were published in recent issues of the *Monthly Labor Review.*

The field work in connection with studies of wages and hours of labor in the pottery, cement, and lumber industries has been completed, and in the case of the lumber industry the data have been tabulated. Summaries of the information obtained in the surveys of wages and hours of labor in air transportation, the boot and shoe industry, woolen goods manufacturing, the dyeing and finishing of textiles, the tanning industry, and sawmills have been carried in recent issues of the *Labor Review*, as well as a preliminary report on union scales of wages and hours of labor.

The results of the study of the relative cost of material and labor in building construction, which had been in progress for some time, were published in the October *Labor Review.* The data were taken directly from the records of building contractors and cover a total of 204 residential and nonresidential buildings in 15 cities.

Another special study pertaining to the building industry was that of the man-hour activity in the construction of an apartment house in Washington, D. C., the results of which were also published in the October *Labor Review.* This study shows the amount of work, in terms of man hours, done by each occupation or trade, the duration of work for each class of employees, and the particular periods during which the several classes of employees were actively employed.

During recent months the Bureau has made studies of man-hour productivity in several industries, using as basic data the statistics collected by the Bureau of the Census in the Census of Manufactures for 1929. Two of these, covering blast furnaces and the lumber industry, were published in the August and October issues, respectively, of the *Labor Review*. A similar article covering oil production is now being prepared for publication.

Activities of the Bureau of Agricultural Economics.—A preliminary mimeographed publication entitled "Tentative Estimates of Gross Income from Farm Production, Current Value of Agricultural Capital, and Selected Expenditures, 1909–1931," prepared by the Committee on Farm Income, O. C. Stine, Chairman, L. H. Bean, Secretary, was issued in July, 1932.

Mr. L. H. Bean of the Division of Statistical and Historical Research, prepared in May, 1932, for hearings at Kansas City before the Interstate Commerce Commission, a statement entitled "Facts Relating to the Agricultural Situation." This is composed largely of statistical tables and charts.

A forthcoming publication, prepared by G. B. Thorne and Preston Richards of the Division of Statistical and Historical Research, will have the title, "Factors Affecting Exports of United States Hog Products."

A mimeographed publication, prepared by L. R. Edminster and others in the Foreign Agricultural Service of the Bureau, and released in July, 1932, deals with "Agricultural Price-Supporting Measures in Foreign Countries."

In Senate Resolutions 280 and 281, respectively, both adopted in July, 1932, the Senate requested the United States Department of Agriculture and the Federal Farm Board to investigate the restrictions upon international trade in major agricultural products throughout the world, the measures being taken to protect farm products, and the effect of these restrictions and measures upon the American farmer; also to investigate the economic situation of hog producers, and the way in which proposed plans for farm relief would affect hog producers.

Members of the Bureau have participated in regional agricultural outlook conferences during the year as follows: the Western Outlook Conference, in Salt Lake City, August 11–12; the Central States Outlook Conference, in Chicago, September 14–16; the New England Outlook Conference, in Boston, September 29–30; and the Southern Outlook Conference in Atlanta, November 8–11.

Source Book for the Study of Industrial Profits.—A *Source Book for the Study of Industrial Profits*, containing a series of coded tables presenting financial statistics for certain groups of corporations from 1919 to 1928, has been released by the Department of Commerce. Dr. Ralph C. Epstein of the University of Buffalo prepared the Source Book in collaboration with Florence M. Clark.

The Source Book is designed solely for the use of research economists and expert statisticians, and is not intended as a hand book for reading or reference by the general public.

Its tables, extending over the ten years ending with 1928, show, for each group of corporations, sales, total net income, capitalization, bonded debt, federal income tax, dividends received, inventories, cash dividends, capital assets, patents and good will and frequency distribution of capitalizations.

Only figures for groups of corporations are given, the identity of information on individual corporations being concealed.

Copies of this publication can be obtained from the Marketing Service Division, Bureau of Foreign and Domestic Commerce, for $1.00 a copy. The charge for this is in conformity with the requirements made in recent legislation.

Annual Report of the Social Science Research Council.—Copies of the Annual Report of the Social Science Research Council (230 Park Avenue, New York) are available to individuals on request. The new report appeared in December.

Annual Report of the Federal Reserve Board.—The complete edition of the Annual Report of the Federal Reserve Board for 1931 became available to the public in September, and will be sent without charge upon application to the Secretary of the Board. In addition to the review of the year's financial and industrial developments, released for publication earlier in the year, this edition contains statistical records covering a considerable period of years for Federal reserve bank credit, member and non-member bank credit, money rates, monetary gold stock, money in circulation, and general business conditions.

Pennsylvania Department of Labor and Industry.—Under the provisions of a law enacted by the special legislative session of 1932 on unemployment relief, allocations of a $12,000,000 relief fund to county relief boards are made on the basis of estimates of unemployment prepared by the Department of Labor and Industry. Allotments of a $10,000,000 relief fund provided by the special legislative session of 1931 were made on the same basis. Twenty-two millions of dollars of relief funds have been appropriated by the Pennsylvania Legislature within the last year.

The Department is engaged in a survey to attempt to learn from industry what proportion of the number of workers employed in the peak year of 1928 and 1929 are expected to be re-employed when the production level again reaches 1928–1929 proportions. The survey, of course, will disclose only opinions on the subject, but preliminary returns indicate that employers in many industries have very definite ideas on the subject.

The highly publicized reopening of industrial plants in recent months has led the Department to investigate on its own account the number and extent of plant reopenings with a dual purpose in view: (1) to attempt to measure the actual extent of industrial recovery, and (2) to insure that the reopened plants are immediately inspected for working conditions. Preliminary reports of investigations have disclosed that the importance of the industrial recovery is being overemphasized by the press, and in a surprising number of instances it was discovered that the press reports of plant reopenings were without foundation. Preliminary reports of inspection as to safe working conditions indicate that a factory that has been closed for any considerable length of time is, upon reopening, in need of a thorough inspection to insure that the laws and regulations relating to safety and to the employment of women and children are being observed.

A study of the rate of blood poisoning in compensable industrial accident cases in Pennsylvania over the ten-year period, 1921–1930, shows an average rate of infection in all industries of 5.0 per cent. In five industries the rate of infection was found to exceed one case of blood poisoning in every ten compensable accidents. These five industries are the clothing, hotel and restaurant, leather and rubber, textile and food industries. Over the ten-year period covered by the survey, an increasing rate of infection is shown for all industries except coal mining. The rate of infection for all industries increased from 4.8 per cent in 1921 to 5.8 per cent in 1930.

Centenary of the Royal Statistical Society.—During 1934 the Royal Statistical Society (British) completes the first hundred years of its existence. The anniversary, it is hoped, may be celebrated coincident with a meeting of the International Statistical Institute in London.

A Biological Study at Johns Hopkins University.—A coöperative biometrical investigation of the quantitative relations of the endocrine glands in man, with Dr. Walter Freeman, Pathologist and Director of Laboratories of St. Elizabeth's Hospital, and Professor of Neurology in George Washington University, in charge of the pathological aspects, and Dr. Raymond Pearl, in charge of the biometric aspects of the study, is in progress in the Department of Biology of the School of Hygiene and Public Health of the Johns Hopkins University. The investigation is supported by a grant from the Josiah Macy, Jr., Foundation to the George Washington University Medical School. Miss Marjorie Gooch, Associate in Neurology of George Washington University, has been appointed a Fellow in Biology in the School of Hygiene of the Johns Hopkins University in connection with the project.

The Brookings Institution.—In the field of radio discussion the Institution has been asked by the National Advisory Council on Radio in Education to sponsor a program on current economic and governmental problems, given over a nation-wide network on successive Saturday evenings, beginning November 12. Earlier in the autumn Mr. Henry P. Seideman and Mr. W. F. Willoughby, of the Institute for Government Research, coöperated actively in the "You and Your Government" series of broadcasts presented by the National Advisory Council in coöperation with the American Political Science Association.

The Institute for Government Research, at the request of Governor Winant, has made a general survey of state and local government in New Hampshire, and the report is now in progress. Research projects recently brought to completion by members of the Institute of Economics are as follows: Felix Morley, The Society of Nations; R. R. Kuczynski, Bankers' Profits from German Loans; Harold G. Moulton and Leo Pasvolsky, War Debts and World Prosperity; Charles O. Hardy, Credit Policies of the Federal Reserve System.

Dr. Leverett S. Lyon, on appointment as delegate by the State Department, attended the congress on commercial education which met at London, July 25-30. Leo Pasvolsky, now in Europe engaged in a study of currency and credit conditions, is appointed delegate to the International Chamber of Commerce meetings at Paris in December.

During the summer, Dr. C. O. Hardy, on leave from the Institute of Economics, taught at Ohio State University. Dr. Lewis Meriam, on leave from the Institute for Government Research, conducted courses at the University of Chicago on public administration with special reference to national government.

PERSONALS

Miss Mary van Kleeck, a Vice-President of this Association, presided at the meetings of the Second International Conference of Social Work held in Frankfort-on-Main from July 11 to 14. Miss van Kleeck is also an Associate Director of the International Industrial Relations Institute.

Major P. Granville Edge, O.B.E., has been spending several months in Shanghai, China, organizing a new division of Medical Statistics in the Henry Lester Institute for Medical Research. It is anticipated he will be away about a year.

Dr. John W. Gowen, Associate Member in charge of genetics in the Department of Animal and Plant Pathology of the Rockefeller Institute for Medical Research, is spending a sabbatical year in the Department of Biology of the School of Hygiene and Public Health of the Johns Hopkins University. With Dr. Gowen in Baltimore are his assistants, Dr. Ralph G. Schott and Miss Elizabeth H. Gay.

Miss Emma A. Lundberg is serving as Statistician of the New York State Temporary Emergency Relief Administration.

Trustees of the University of Pennsylvania have announced the election of Dr. Joseph H. Willits, Professor of Industry and Director of the University's Department of Industrial Research, to the Deanship of the Wharton School of Finance and Commerce of the University, succeeding Dr. Emory R. Johnson. Dr. Willits will assume the new office in June, 1933.

OBITUARY NOTE

Floy Hotelling, whose studies of causes of birthrate fluctuations were published in part in this JOURNAL for June, 1931, died October 2 of heart disease.

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REVIEWS

A Mathematical Reformulation of the General Theory of International Trade, by Theodore Otto Yntema. Chicago: University of Chicago Press. 1932. xii, 120 pp.

Professor Yntema's purpose in this compact volume has not been to reach conclusions on the major problems of international-trade theory which are essentially novel, but rather to restate the existing classical doctrines in mathematical form, insofar as they are capable of such statement, and to reconcile or correct earlier mathematical treatments in the light of his own formulation.

The general orientation and character of the analysis can be indicated in brief compass. The basic proposition is that since in international trade the repercussions of given changes are commonly important, and the changes themselves of substantial magnitude, the traditional approach through the *ceteris paribus*, one-thing-at-a-time assumption, is usually inadequate: the approach through simultaneous equations is more appropriate. Professor Yntema, therefore, proceeds first to determine the conditions and simultaneous equations of equilibrium in international trade in a simplified case, in which only commodities are considered. The conditions which permit equilibrium equations to be set up are the fact that the money value of each export of a commodity from one country equals the money value of the import of the same commodity into some other country (costs of transportation being neglected); and the fact that, in equilibrium, the total value of each country's aggregate exports in a given period equals the total value of its aggregate imports. The type of "equilibrium" at issue thus turns out to be the equilibrium of the balance of payments alone; no real attempt is made to establish the conditions of the underlying (dynamic) equilibrium between productive powers, utilities and "human" costs in the several countries. The demand and supply-cost functions for the commodities entering international trade are taken as given; and the corresponding prices and quantities, together with the elasticities involved, become the units of the mathematical analysis. On this basis, a series of simultaneous equations are set up, which permit the derivation of determinate equilibrium values for the unknown prices and quantities. The chief novelty here is that instead of dealing with *absolute* demand and supply price schedules, Professor Yntema deals with what he calls "fixed-height" schedules, in which the actual values are deflated to terms of a constant monetary situation; and then introduces a compensatory "net monetary factor" to allow for the combined effects of fluctuations in the exchange rates and changes in general price levels. This device has various advantages, especially the clarification it permits of the *relative* movements of sectional price groups; and it makes possible the establishment of equations for international trade which are directly cognate with those which may be simultaneously established for internal trade.

With these basic equilibrium equations set up, Professor Yntema then refines them, and introduces the complexities of actual trade conditions. These complexities are, in chief, costs of transportation (which are properly treated like a commodity demanded jointly with the commodities actually shipped), the invisible items, and tariffs and bounties. Their effect is to disturb the previously existing balance of payments, and to lead to the establishment of a new balance with changed heights of schedules and changed equilibrium prices. On the assumption that the changes in spendable funds within the countries concerned, which result from the operation of tariffs or bounties and of the "invisible" payments, are generally distributed, and by starting with extremely small changes, it is then possible to set up differential equations which permit a description of the new equilibrium situations. As before, the equations are stated in terms of money demand and supply schedules; but if some unique simplifying relation be assumed to prevail between money costs and prices and "human" or sacrifice costs and utilities, the transition to the classical doctrine of comparative labor costs is easy.

It is always risky for a non-mathematician to discuss an analysis resting on mathematical methods; he is likely to make stupid and unfair criticisms, and is still more likely to miss the ingenious subtleties which have especially pleased the mathematical author. There are nevertheless certain points to which attention may be called. First, Professor Yntema deliberately assumes that changes in trade conditions which are due to monetary factors shift *all* demand and supply schedules proportionately (pp. 3, 6 ff.). The assumption seems necessary to simplify the analysis, but it is unreal; the one thing which is clear about changes in the quantity of money is that they do *not* affect the different kinds of prices equally or in proportion. Nor is it by any means necessarily true that loans or other unilateral payments even "tend," under present-day conditions, both to increase the quantity of the circulating medium in the country receiving the payments, and to diminish it in the country making them (pp. 27, 61). And surely "constant" monetary conditions should entail stability of the price-times-quantity term, not of the price term alone (p. 5n, ff.). Second, the treatment of decreasing costs seems inadequate (pp. 9, 41 ff.). I have nothing better to suggest, but I am bothered by the apparent failure to recognize possible differences in the shape and even the slope of the cost curves as between foreign and domestic (if any) sources of supply; or to recognize that even if the domestic cost curve is decreasing, the decrease may not be rapid enough to eliminate imports; or even to distinguish clearly in any case between the imported and the domestic parts of the total supply. Third, the attempt to measure the terms of trade in resources-costs (p. 19) seems to me open to much the same objections that apply to the classical measurement in terms of human costs; it is necessary to assume an arbitrarily constant or at least determinate multiplier, to obtain the actually observed money costs. Fourth, the definition of "equilibrium" and its stability not only runs primarily in terms of the balance of payments alone, but is also, when refined, rather confusing to the non-mathematical mind. In the discussion of stability of equilibrium (especially p. 87) it is not clear what is really meant by "stability." The question of the elasticities of supply and demand, which Professor Yntema stresses particularly, would appear to bear not so much on the balance-of-payments equilibrium itself as on that underlying equilibrium of productive powers, purely domestic conditions in relation to international-trade conditions, and the like, which at most points he explicitly disregards.

The Greenbacks and Resumption of Specie Payments, 1862–1879, by Don. C. Barrett. Harvard Economic Studies, Vol. XXXVI, Cambridge University Press. 1931. x, 250 pp.

In this monograph, Professor Barrett has presented "in monographic form a critical account of the difficulties, the pitfalls, and the outcome of our experiment during the entire greenback period from 1862 to 1879." One chapter in the volume (No. II) was originally published some years ago as an article in the *Quarterly Journal of Economics*, while Chapter III and the early part of Chapter V are based largely upon Mitchell's *History of the Greenbacks*. Other chapters contain original material particularly appertaining to the later history of the paper currency, and to the difficulties attending upon resumption—a relatively less-known phase of the experiment. The form of the book is attractive, the print legible, the proof-reading generally good. Perhaps, however, it may not be over-critical to suggest the desirability of omitting the "p" in "Fort Sumpter."

The greenbacks and their history have been so widely discussed and so generally treated, as if they represented a thoroughly-explored field of monetary research, that it is often supposed there is little or nothing to be added to the reviews of the topic now available. Those who have entertained such a feeling will find themselves agreeably surprised upon perusal of this new monograph, for it furnishes a wealth of heretofore unavailable data carefully collected from contemporary publications, and a careful arrangement of more familiar material which throws its salient elements into much bolder relief than has been the case in many of the earlier discussions. It is thus a useful contribution to American monetary history.

The book is, however, more than a historical monograph; since it turns—as the author himself has observed—a good deal of light upon the difficulties of resumption. This portion of the work might to great advantage be read by those of our contemporary economists who are now urging in much the same terms that were then current, the retention of an inflationary element in the currency as a necessary step toward the attainment, or restoration, of prosperity. It was exactly this controversy which filled the years between 1870 and 1879 and subjected the nation to what Professor Barrett has well called a "decade of debate and delay." As he remarks at one point (p. 167):

> A wave of economic heresy had struck the people [shortly after the close of the Civil War] . . . The fear of contraction was used as a political expedient to catch votes. . . . The greenback movement which took form at this juncture, and the followers of which regarded inflation of the currency as a means of curing all economic ills, found encouragement in crop failures . . . and business troubles.

Both parties vied in their allegiance to inflation; and the panic of 1873 merely added fuel to the flames. Gold exports, bad business, lack of confidence on the part of foreign countries, reduction of foreign trade, and many other factors only too familiar as elements (as history has repeated itself) in the events of the past year or two, speedily followed. It is a gloomy chronicle of unsound public opinion—closed by a fortuitous success in the restoration of technical soundness rather than by any definite demonstration of allegiance to principle that closes the history of Resumption. There is much in this experience that is of large contemporary value in its teaching, not only as to public finance but likewise with regard to the growth and development of public opinion, regarding financial and monetary questions.

There is some ground for regretting that, after a convincing picture of the harm resulting from our greenback experiment, the author of this monograph should reach a conventional conclusion regarding the ultimate disposal of the legal tender notes. He says:

> Were they a continuous menace to sound currency, or did they constitute a convenient form of currency and a good device for saving the government interest on $34,000,000? The reasonable reply . . . seems to be that, so long as the people were not convinced that the greenbacks must be redeemable in gold, they were a menace; but when, in the course of time, they came to constitute a negligibly small element in our currency as a whole, and their redemption was beyond doubt, they could not be considered inconvenient or dangerous.

Thus our author leaves the greenback question—so far as principles are concerned—about where he took it up.

H. PARKER WILLIS

Columbia University

Short Selling, by J. Edward Meeker. New York: Harper and Brothers. 1932. vii, 271 pp.

In this book Mr. Meeker erects a very elaborate, imposing, and detailed defense for the practice of selling stocks short, but it is not so creditable a piece of work as would be expected from an authority on the subject. Parts of the book are excellent and above criticism, but other parts are not. The historical development of the practice of short selling and the review of the legislation prohibiting and regulating it are well written and interesting. The explanation of what short selling is and how and why it is carried on deserves praise, but when one reads Part IV, "The Case Against Short Selling," one wonders why there is a section with this title when it is devoted almost exclusively to arguments *for* short selling. An impartial study would suggest at least equal treatment of both sides of the case.

Mr. Meeker even goes so far as to disprove his own statements by using actual data! On page 68 one reads:

> Statistical evidence in this regard (see Part VII, subhead "Analysis of 1931 Short Interest Figures") also shows that, as a matter of fact, *the short interest increases more often and to a greater extent when prices are rising*—not when they are falling. This tendency is natural from the standpoint of the short seller's self-interest. Any particular short seller acts in competition with other short sellers. If he thinks that prices are too high, it is from his standpoint safer to *sell stocks short while prices are still rising*, and to cover his short sale when prices are falling. If he waits to sell until the decline begins, and waits to cover until the rebound has started, he is in danger of "missing his market" in both directions. . . . This is the reason why short selling actually stabilizes fluctuations, *since usually the short seller operates against rather than with the prevailing price movements* in the market.[1]

Actually in Part VII, page 140, one reads, "This [data] indicates that when prices rose, *usually the short interest was declining substantially;* [1] . . ." On the same page one reads, "Consequently these figures support the view that: (1) Rising prices have generally been accompanied by short covering, as shown by a diminishing short interest; . . ." Mr. Meeker flatly contradicts himself and is inconsistent. The data given in the appendix and *his own analysis of it* on page 140 prove exactly the opposite of what he claims is true on page 68. These data are interesting when associated with a statement quoted during the Congressional hearings on short selling. "The 'astute traders' of the economists don't fight the market trend and act as a brake on the top. They wait until it is well over the top, then they get behind and push it down as far and as fast as they can."[1]

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[1] Italics are the reviewer's.

Mr. Meeker endeavors to prove that the stocks not subject to short selling crashed harder than those which were subject to short selling. On page 70 one reads, "The chart of unlisted bank stocks and listed shares already cited clearly shows that the market for the former crashed harder than that for the latter, despite the absence of short selling in the first instance and its presence in the second." Listed stocks are subject to more trading which gives them greater liquidity or better marketability. Only part of this trading is attributable to short sellers, so it is not a fair test to compare listed with unlisted securities so far as violent fluctuations are concerned. A better method of approach would be to compare listed securities in which there was a relatively large amount of short selling with listed securities which were subject to little or no short selling. Mr. Meeker's argument comes to this:

> Listed stocks fluctuate less in price than unlisted stocks.
> Listed stocks are subject to short selling while unlisted stocks are not.
> Therefore, short selling causes less fluctuation in price.

This conclusion is qualified in the next sentence, for one reads on page 77, "If in 1929 short selling in the stock market had been more intensive, listed stocks would *presumably*[2] not have risen so high in the summer nor fallen so sharply in the autumn.

Mr. Meeker presents far too good a case for short selling. Short selling is generally regarded as a valuable practice when carried on by trained individual speculators, but it may become dangerous when used by a large pool. The free and open market which the New York Stock Exchange claims to provide really assumes that no pools operate and that all people act individually and independently, for even Mr. Meeker writes,[3] "The 'free and open market' maintained by the Stock Exchange demands, as is made clear in the distribution statement, that 'all stock is free for sale and is held under no syndicate, agreement, or control.'" It is difficult for Mr. Meeker to view short selling from an unbiased standpoint, as this book indicates. The reviewer sincerely hopes that Congress does not prohibit short selling without providing some substitute, but he must still maintain that Mr. Meeker's defense of the practice is too enthusiastic and in some degree erroneous.

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[1] "Short Selling of Securities." Hearing before the Committee on the Judiciary, House of Representatives, Serial 5, Part 1, February 15, 17, 19, 24, 1932. P. 12. The reviewer has made a statistical study of the data on short selling published by the New York Stock Exchange, but the limitations of this review do not permit an adequate presentation of the results. There is no significant correlation between short selling and the index of stock prices over the entire period for which data are available. For short periods the correlation is sometimes positive and sometimes negative, but the correlation is too small for periods sufficiently long to enable one to draw the conclusion that short selling stabilizes price fluctuations.

[2] Italics are the reviewer's.

[3] J. Edward Meeker, *The Work of the Stock Exchange*, p. 101

HARRY PELLE HARTKEMEIER

University of Missouri

New Methods of Measuring Marginal Utility, by Ragnar Frisch. Tübingen: J. C. B. Mohr. 1932. 142 pp.

Dr. Frisch's first statistical attempt to measure utility is based on the records of a Paris coöperative society between June, 1920, and December, 1922. From these are deduced for each month three quantities: the amount of sugar consumed per capita by the membership; income per capita, judged apparently by the total sales of the society, divided by a cost of living index; and a ratio between the price of sugar and the cost of living. A curved surface is fitted, corresponding to an equation among these three variables, which are denoted respectively by x, r and α. This, with the mathematical theory of utility developed, gives the marginal utility of money as a function of income. According to this analysis, the marginal utility w of a deflated dollar is the product of α and the marginal utility $u(x)$ of a pound of sugar when x pounds are used. The equation of the surface is, in fact, $w(r)=\alpha u(x)$. By taking a section, $x=$ constant, of the surface, a relation is obtained giving α, and therefore the marginal utility w, as a function of the real income r. With the happy readiness to mix Greek with Latin which characterizes Scandinavian statisticians who write in English, Dr. Frisch calls this the isoquant method.

In order to use wartime household budget data for graduation of a utility curve, the author adopts two other procedures, which he calls the quantity variation method and the translation method. The former is based on the *quantities* of food purchased in different groups as functions of income; the latter on *expenditures* on food. The translation method is applied to budgetary data gathered in thirteen American cities in 1918–1919, and there results on page 64 a table giving the marginal utility w corresponding to each of twelve levels of real (deflated) income r. When r increases from 2.40 to 6.50 (necessarily arbitrary units) w diminishes from 10.00 to 6.72, while the "flexibility" of the curve, defined as $-\frac{d \log w}{d \log r}$, declines from .617 to .261.

These methods proceed from a theoretical basis slightly different from that of the method published by Irving Fisher in 1927, which involved comparison of expenditures by similar families in two places on two commodities. At that time Professor Fisher apparently slipped into a conclusion, based on a criterion of "equality of sacrifice," which to him meant equal decrements of utility, that an income tax ought to be levied with lower rates on the rich than on the poor if the flexibility of the money utility curve should turn out to be less than unity. Dr. Frisch's statistical studies now indicate that the flexibility is actually less than unity, but he does not share Fisher's tacit assumption that the "equal sacrifice" principle is the only one possible. A chapter is devoted to various possible criteria for income tax graduation. Of these, the one which commends itself most is the principle of minimum total sacrifice of F. Y. Edgeworth and T. N. Carver, and this leads to complete equalization of incomes, independently of the form of the utility curve, except as the principle may be modified so as to encourage production.

The chapter on index numbers contains some excellent ideas. A chapter on money utility and the supply curve of labor includes a rebuttal of the argument that a labor supply curve must always slope downward, and a discussion of doles and poll taxes in relation to this curve. At the end of the book, an interview or questionnaire method is suggested for evaluating utility functions.

To the doubts whether utility is objective, the reply may be made that demand and supply functions are objective things, and that if utility is defined as an integral or other functional of these functions, it too is objective. In this sense, utility has the same legitimacy as a physical concept such as work or potential, which is the line integral of force, provided certain integrability conditions are satisfied. The weaknesses of discussions of utility which start on a psychological basis are those of treatments of force which start from muscular exertion. This sort of a start may indeed be excellent, but if an author has too great a horror of equations it leads nowhere, either in physics or in economics.

The statistical evaluation of the functions involved is a difficult matter, and this book, like Professor Fisher's paper of five years ago, is more concerned with telling how to work them out than with showing the numerical results accomplished. But the methodological discussion leaves an important gap in failing to mention the probable errors, which are obviously large. Free-hand smoothing, which the author has used in places, is indeed essentially defective in this respect. In order to carry conviction as to the utility of the utility concept, it will ultimately be necessary, not only to find data for which fairly accurate evaluations can be made, but to demonstrate that these evaluations are accurate. To show that there is real accuracy, free-hand methods can never suffice.

HAROLD HOTELLING

Columbia University

The Street Railway in Massachusetts, by Edward S. Mason. Cambridge: Harvard University Press. 1932. 222 pp.

Amply illustrating many contemporary aspects of the unsolved general problem of privately-owned public utilities, Professor Mason's analysis of the history of the street railway in Massachusetts possesses more than local interest. As was the case with the steam railroad before, and with the electric light and power industry later, the chief spur to the construction and consolidation of electric railways in Massachusetts appears to have been derived from the profits of promotion and the sale of securities. The Massachusetts system of control of the securities issues of public utilities prevented much of the flagrant stock-watering that accompanied the growth of street railways in other states, but its administration was sufficiently lax to make the profits of new flotations attractive to underwriters and distributors of securities. The holding company, moreover, was early invoked in connection with street railway enterprises, as it has been more latterly in connection with the electric power industry, to loosen the restrictions, in part, of public regulation. Public control was wholly ineffective in keeping the investment in the industry within economically sound limits. So long as investors could be persuaded to buy street railway securities, new lines continued to be built and old ones consolidated, after all other justification for expansion or combination had ceased to exist. The investment attractiveness of such securities was artificially created, maintained, or enhanced by the payment of unduly high dividends, which were made possible by a radical neglect of adequate depreciation charges. There was little attempt on the part of the public authorities to enforce adequate standards in the latter respect.

The qualities of stability, monopoly, and government protection that commonly give high value to the securities of public utility enterprises proved to be largely illusory in the case of the electric railways. Accompanying the rise in the general price level, there was an increase of about 20 per cent in street railway operating costs between 1900 and 1914. The rates of fare, nevertheless, remained largely stationary. Indeed, the effective rate of fare was actually reduced over large areas as the result of the absorption of outlying lines by urban enterprises which extended the distance covered by their standard five-cent fare to their new territories. Most illuminating of the reasons advanced by Professor Mason for the unwillingness of the companies to petition for fare increases during this period was the fact that such petitions would have forced them to disclose their unsatisfactory earnings status, and would thus have impaired their ability, and that of their holding companies, to market securities.

The long-growing difficulties of the street railways were climaxed by the rapid and enormous increases in operating costs during the War and post-war years. Large and small companies went into receivership and hundreds of miles of line were abandoned. Fare increases were now belatedly requested and more belatedly granted, but the demand for street railway transportation proved to be surprisingly elastic, so that higher fares produced disproportionately small increases in revenues. The decade following the end of the War, with its amazing growth in the use of private passenger automobiles and motor busses, sealed the doom of the electric street railway in all but the most populous urban centers.

Professor Mason's attractive style easily carries the burden of detailed exposition, and the import of his study is of broader significance than the monographic character of the subject might suggest. The book contains a considerable body of descriptive statistics, and an excellent analysis and index of street railway operating costs for the period 1900–1925.

LAWRENCE H. SELTZER

College of the City of Detroit

Japan: An Economic and Financial Appraisal, by Harold G. Moulton, with the collaboration of Junichi Ko. Washington: The Brookings Institution. 1931. 645 pp.

The difficulties presented by the Japanese written language have led American and British students of economics to resort to methods of study of Japanese economic conditions that would not be regarded as permissible in dealing with conditions in a continental European or a South American country. Dr. Moulton's work, however, differs from the average Western study—usually constructed from the extremely limited materials available in Western languages supplemented by observation and interviews—in being based on a very extensive collection of materials translated from Japanese by Dr. Moulton's collaborator. This represents a great advance on previous academic studies in this field. There is, indeed, no adequate reason why in the future our universities and research organizations should not be able to train a certain number of economics students in Oriental languages instead of mechanically insisting that every student concentrate on two European languages. For some time, however, Moulton and Ko's work is likely to remain the best general introductory work in the English language to Japanese economic conditions. It is a comprehensive and well proportioned economic survey of Japan, and supplies a want felt for a long time by American and British students, who are now, with the publication of this and of Dr. and Mrs. Orchard's important, though more specialized study, much better provided with materials than they were before 1930.

Within the limits of a brief review no attempt can profitably be made to describe the contents: every student interested in Japanese economic conditions should discover these at first hand. It will imply no disparagement of the book as a whole if part of the remaining space is taken up with criticisms of a few points of detail.

It is unfortunate that in the descriptive section, which occupies the larger part of the book, detailed references to the Japanese sources utilized by Mr. Ko, apart from the statistical sources, are largely omitted. Japanese titles could easily have been given in romanized form. Some of the tables could have been simplified by the use of significant figures only.

The relative importance of different industries at selected time intervals is estimated on the basis of relative gross values of output and relative numbers of workers. The first of these methods is generally recognized as unsound, and I have tried to show elsewhere that the second cannot be safely applied to Japanese industries, nor do I think that it is logically defensible in any case. A number of writers on Japan have gone astray on this point, possibly owing to vague ideas as to the meaning of relative or comparative "importance." It is the relative contribution of an industry to the national income which properly constitutes its relative importance.

Though Dr. Moulton considers that "on the whole, Japanese statistical methods and data now compare favorably with those of other countries," he has omitted to describe the methods of compilation of primary data given in official sources. In point of fact the lack of censuses of production in Japan places data on quantities and values of production on a far lower plane than similar data for America and England. Moreover, there is no approach to a cost of living index number for Japan.

It is a weakness of this book, considered as an economic survey, that its treatment of agriculture is relatively very brief and conventional. Incidentally, I shall not be alone in dissenting from the view that "to the traveller it appears that almost every available inch of land is utilised." However, Moulton and Ko are perhaps less at home in agriculture than in industry and finance and may be quite justified in concentrating mainly on the latter. The treatment of public finance and of financial organization is specially valuable.

Notwithstanding the case which Dr. Moulton makes for the return to gold at the pre war parity, I doubt very much whether Mr. Inouye's policy in this matter was wise. In particular the strain placed on agriculture by the deflationist policy was serious, and the political discontents which paved the way for the seizure of power by the militarists were not altogether unconnected with monetary policy.

Lack of space prevents me from quoting Dr. Moulton's important, and, I believe, sound judgment of the results on balance of Japanese economic penetration of China (pp. 470–473), and of his, to my mind, convincing argument that "while the possession of raw materials is undeniably of importance, it is not indispensable to the development of industry." It is to be hoped that what Dr. Moulton has to say on both these points will, when it appears in the Japanese translation by Mr. Ko, receive careful attention in Japan.

E. F. Penrose

Food Research Institute
Stanford University

The Revision of the Price Index Numbers, by T. Sheng. Bulletin of the National Tariff Commission. Ministry of Finance, National Government of the Republic of China, Shanghai. 1931. 30 pp.

In China the art of index numbers has been developing rapidly in recent years. The revision described in this pamphlet marks an important step forward.

The revision was made largely to afford better comparisons than the old index numbers afforded because of differences in the choice of bases and because of badly chosen formulas.

As with many recent revisions of index numbers in other countries, the simple arithmetical average has been abandoned because in comparing two dates it does not work both ways consistently. The fixed base system is used, the base being 1926.

The new formula used is the simple geometric, except for the export and import indexes for which weights are available. The weighted arithmetical is then employed, the weights being the values imported or exported.

The indexes of Wholesale Prices in Shanghai include sub-indexes for cereals, other food products and provisions, textile fibers and manufactures thereof, metals, fuel and lighting, building materials, chemicals and preparations thereof, and miscellaneous, as well as the General Index.

The indexes both of Export Prices and of Import Prices in Shanghai include agricultural products, forest products, mineral products, the average of the preceding three, producers' goods, consumers' goods and a general index.

The resulting figures are of great interest today because China is now the only important country remaining on the silver basis. The ratio of gold to silver which was 1 to 29 in 1925 fell to 1 to 79 in February, 1931. While gold standard countries have been suffering from a fall in prices since 1929, China "has been seriously affected" by rapidly advancing prices. This is one more evidence of the domination of money over the price level. Those who think otherwise should study this pamphlet. The general wholesale price index for Shanghai rose from 100 in 1926 to 129 in June, 1931 (the latest figure in the table). The index of export prices rose in the same period only to 111.7 while the index of import prices reached 160.1. The general wholesale index of the United States Bureau of Labor Statistics for June, 1931, on 1926 as 100, fell to 70.

IRVING FISHER

Price Sources, U. S. Department of Commerce. Washington, D. C. 1931. 320 pp.

This manual presents an alphabetical list of "commodities," each entry in the list showing the name of a publication giving regular price quotations, the frequency of its publication, and a geographical specification of the market or markets. An appendix gives alphabetically the publications cited, of which there are a few more than 1,000. The publisher and address of each are stated. The manual was compiled from the publications received in the libraries of the Department of Commerce by Elizabeth M. Carmack. The commodity captions employed include both individual commodities and group terms such as "metals," and "grains." Some commodity index numbers are listed. Several of the captions, moreover, do not refer strictly to commodities, e.g. "stocks," "freight rates," "exchange," and "wages." Although foreign quotations are included, the majority of quotations are for American markets. Little attempt is made to give specifications for the quotations. Different grades or conditions of a commodity are often but not always distinguished. Thus there are "potatoes," (unspecified), "sweet-canned," "sweet," etc. "Wheat" is not sub-classified. Although it is not so stated, the quotations may with few exceptions be presumed to be wholesale. Even without any attempt at evaluation of the quotations and in spite of the fact that it will get out of date, the compilation should be useful to statisticians.

MORRIS A. COPELAND

University of Michigan

Commercial Banks, 1913–1929. League of Nations, Economic Intelligence Service, Geneva. (World Peace Foundation, 40 Mt. Vernon Street, Boston, Massachusetts.) 1931. 429 pp.

The Economic Intelligence Service of the League of Nations has recently issued a *Memorandum on Commercial Banks, 1913–1929*, which classifies commercial banking statistics for all countries on a common basis in so far as this is possible. The compilation endeavors to include all banks in each country, and presents statistics for these banks showing both income and balance sheet items.

In almost every country, statistics such as these are watched with unusual interest by students of domestic economic trends. They rank among the more important economic series, partly because of the important part which banking plays in modern economic life, and, partly, because statistics of banking are more easily gathered and published than other economic series of comparable significance.

The fact that banking figures are important, however, and that they are readily available in a large number of countries has not meant that banking conditions as between different countries could be readily compared. In each country, those figures which are available represent samples covering predominantly the larger banks in the larger cities. The comprehensiveness of the figures, consequently, is always open to question and varies widely from country to country. Commercial banking institutions, also, vary widely in their organization and scope. It is not safe to compare balance sheet aggregates of banks in a country such as the United States where banking is organized primarily on a unit basis with similar aggregates in Great Britain with its handful of huge branch banking organizations, or with those from Germany and the other European countries where there is no such segregation of commercial and investment banking functions as is common in Great Britain and the United States. Finally, the definition and classification of the most significant banking figures vary widely as between countries so that it is frequently impossible to compare items bearing the same caption, even an item as easily defined as "cash on hand," which may consist of actual currency and coin, or may include balances with the central bank, and sometimes actually includes balances on deposit with other commercial banks, and even checks and other credit items in process of collection. The more important items of "capital funds," "deposits," "loans," and "investments" and their significant constituent elements are much more difficult to compare since seemingly slight differences in definition or classification of these items may lead to wide discrepancies in the published totals.

The figures published in the *Memorandum on Commercial Banks, 1913–1929*, do not solve these difficulties. The volume is excellent as a source record of banking statistics for international comparisons. Its discussion of the figures, furthermore, brings out the differences between the various series and the special factors which must be taken into consideration in using them. The nature of the data is still such, however, that this document will prove most useful in facilitating the comparison of various banking series. The validity of the conclusions drawn from such comparisons, on the other hand, continues to be highly questionable and will remain so until the pioneer work done in this volume has borne fruit among the nations where banking statistics are compiled.

Winfield W. Riefler

Business Statistics, by John R. Riggleman and Ira N. Frisbee. New York and London: McGraw-Hill Book Company, Inc. xix, 707 pp.

This text is distinctive among the recent flood of books on "business" statistics. The first part of 300 pages is an "introduction to statistical methods," amply covering the usual description of collection, tabulation, graphic methods, averages, index numbers, dispersion, time series and correlation. The second part considers "practical application[s] of statistics in business," having chapters devoted to business forecasting, budgeting, population and purchasing power, production and labor statistics, market analysis, real estate analysis, investment analysis, banking and executive control and management statistics. Appendices are devoted to schedule and questionnaire forms, mechanical aids, drawing and lettering instructions, outline of local commercial and industrial survey, preparation of statistical reports, common logarithms and tables of squares, square roots and reciprocals of numbers to 1000.

Several features distinguish this text. Emphasis is continually placed on the necessity of exercising careful judgment as to the applicability of mathematical techniques which are never fool-proof. Logical analysis is placed on a par with or ahead of technique, as, for instance, in the introduction of correlation, where a coefficient is not mentioned until the nineteenth page. Technical descriptions, such as rules for computing an index number or a method of seasonal variation, are subordinated by the use of small type. Each chapter includes a set of questions and problems; unfortunately most of the questions, after the excellent ones in the introductory chapter, tend, as is usually the case, to be routine review questions rather than thought-provoking. The problems are well-selected and furnish more than sufficient laboratory material. The application chapters (nearly half of the book) are realistic discussions of the problems met in business and economics, and contain a wealth of information concerning source material and guides. They are real text discussions rather than narrow case studies.

There are occasional minor slips of expression and presentation. In the unusually lucid treatment of index numbers (which follows King in omitting all formulas and disregarding the "tests" of good index numbers) no mention is made of link indexes, and no caution is noted concerning the shifting of the base for certain types. The illustration of the calculation of the geometric mean is poorly chosen, as the authors recognize. The correlation discussion, oddly enough, deals only with time series, with no illustration of static correlation (although such is mentioned). The opening six chapters up to "averages" tend to be rather encyclopedic in their meticulous detail; we wonder if the student is here able to assimilate this detail.

The book is markedly characterized by that desirable quality we have been taught to associate with fountain pens, radios, refrigerators and tires, namely, balance; a balance between technique and logic, between mathematics and usefulness, between methods and application. In the latter half, emphasis is put on meaningful results. We would change the title to economic statistics, as the viewpoint is usually broader than that of the business man. The graphic work, typography and general set-up are unexcelled. The book gives evidence of the care exercised in putting it through five mimeographed editions, each put to the practical test of the classroom.

WIRTH F. FERGER

University of North Carolina

Corn and Hog Surplus of the Corn Belt, by Alonzo E. Taylor. Stanford University, Food Research Institute. 1932. 658 pp.

The problem of the corn and hog surplus which is discussed at length in this book is of great interest at this time. The corn crop in 1932 was the largest since 1925 and hog production is increasing. Prices of both commodities during 1932 were the lowest in more than thirty years.

The author divides his book into two parts. Part I contains a detailed discussion of the nature, extent and consequences of a surplus of corn and hogs. The major topics covered in this section are: (1) The production and disposition of corn and hogs in the United States; (2) exports of corn and hog products and the influence of international factors on prices of corn and hogs; (3) the general attitude of Corn Belt farmers and farm leaders with respect to the major economic difficulties confronting Corn Belt agriculture and their causes. Part II deals with the ameliorations of the consequences of a surplus of corn and hogs. The author discusses the various proposed relief measures and how they would probably affect the financial returns to corn and hog producers.

The elements in the corn and hog situation and the general conclusions upon which the author places greatest emphasis may be summarized as follows:

1. The hog surplus, which is considered roughly as the volume of hog products exported, is expected to continue. It will not disappear as did the surplus of cattle and sheep.
2. Most of the hog surplus is in the form of lard. Lard has no distinguishing physical or chemical qualities and is therefore exposed to severe competition from vegetable and marine fats and oils, the production of which has increased greatly in recent years. "The Corn Belt farmer can not be considered as a low cost producer of fat nor is the fat he produces of exceptional qualities." The foreign outlet for both lard and pork probably will become more restricted in future years.
3. Prices of both corn and hogs in this country are determined largely by domestic conditions and not by foreign supply and demand conditions of these commodities.
4. The equalization fee probably would raise hog prices for one or two years if expertly managed, but since hog production could not be controlled the plan would not work for a longer period of time.
5. The export debenture plan is inapplicable to hogs because of the many forms in which hog products are merchandised. Even though it should stimulate prices initially, the higher prices would cause increased production and eventual failure of the plan.
6. The farm allotment plan (as proposed originally by Spillman and Black) is not applicable to corn and hogs.
7. "Internal" methods of relief, which include technical improvements, larger farms, a better utilization of the land and the adjustment of supply to demand, offer considerable opportunity for improving the economic position of Corn Belt farmers.

Many of the conclusions presented represent valuable contributions to the solution of the corn and hog surplus problem, but the author's position with reference to the lard situation, and the theory involved in the determination of probable immediate results from controlling the exportable surplus, are two major considerations in his analysis which are open to question.

The author's position with respect to the lard situation seems unduly pessimistic. His contention that lard is merely one fat of many, that it has no distinguishing characteristics, and that it will continue to lose favor among consumers, is contrary to the conclusions reached by many authorities who have made studies of the qualities of lard. The shortening qualities of lard are quite generally recognized by researchers and by the trade as being superior to those of the competitive oils and fats, not only in Europe but in this country as well. A study of consumption and prices of lard and lard substitutes during the post-war period indicates that the competitive position of lard has weakened somewhat, but not to the extent that the author suggests. Domestic consumption of lard substitutes has been fairly stable since 1925, whereas lard consumption has trended upward. Lard continues to command a premium over most lard substitutes and in European markets American lard sells at a higher level than the lard from other sources. Without doubt, the advancement in technological processes during the last decade has greatly enhanced the competitive position of vegetable and marine fats, but the opportunity to improve quality and demand through further improvements in manufacturing technique appears to be about as great for lard as for other fats and oils. The author admits that during the last decade the lard export trade has been "surprisingly maintained." Exports to Germany have declined during this period, but this has been due largely to increased lard production in that country. The stability of lard exports to United Kingdom has been due largely to the superior quality of American lard and the assurance of a uniform and adequate supply. Considering these elements in the lard situation, Dr. Taylor's evidence in support of his views of the present and prospective economic position of lard is not convincing.

In setting up the hypothesis involved in his appraisal of the various proposed relief measures with reference to selling larger quantities abroad, the author states that "so long as the fraction of the crop consumed at home is large contrasted with the fraction passing to export, the gain to producers on the total merchandised crop would be larger than the loss sustained on the exports." To consider in this connection only the relation of the amount consumed at home to the quantity exported appears inadequate, since the total net returns to be obtained from controlling the exportable surplus depends in part upon the difference in the elasticity of demand for hog products in this country and abroad. It is conceivable that producers might lose from operations involving the withdrawal of supplies from domestic markets to sell on foreign markets, if the demand were very inelastic abroad and relatively elastic at home, even though most of the crop is consumed at home. The demand elasticities may be such as to make the author's statement entirely correct, but the reviewer failed to find any reference to this phase of the problem.

The author's conclusions are based largely on direct interpretation of a vast amount of basic data, supplemented with the results of statistical studies of other research workers. While the lack of well defined organization and the overlapping of subject matter detract from the general usefulness of the book, to the student of the problem it supplies a fruitful source of facts and a comprehensive discussion of the major problems facing the corn and hog industries.

G. B. THORNE

Bureau of Agricultural Economics

Die Agrarkrise in den Vereinigten Staaten, by Julian Gumperz. Veröffentlichungen der Frankfurter Gesellschaft für Konjunkturforschung. Leipzig: Herausgegeben von Dr. Eugen Altschul. N. F., Heft 2. 1931. 182 pp.

The book by Gumperz belongs to a series of publications of the Frankfurter Society on the study of conjuncture. This Society has published during the last three years several interesting studies, mostly methodological in character, relating particularly to the quantitative analysis of the business cycle.

The present study differs from the previous publications of the Frankfurter Society. It is not primarily methodological. Its subject is the analysis of a concrete economic problem: the causes of the present agricultural crisis in America. It attempts also to give a general theory of capitalistic agricultural crises, considering the present crisis in America as a typical phenomenon exemplifying future development in other countries. The book is divided into two unequal parts: the first (only 27 pages) treats the general theory of capitalistic agricultural crises. The second (much larger) presents in some detail an analysis and a theoretical explanation of the post-war agricultural crisis in the United States. The first part is too short to present a well developed theory of agricultural crises, and is limited only to a theoretical outline based on Marxian economic theory. The Marxian law of value, according to Dr. Gumperz, includes all the elements necessary for a total explanation of the social-economic organism and its movements; and Marx's theory of industrial crises furnishes the material for a theory of agricultural crises. We should welcome the position of Gumperz that a theory of economic cycles should explain both industrial and agricultural fluctuations.

I have tried to emphasize the rôle of agricultural fluctuations in the business cycle. Gumperz is not satisfied with my theory because he does not believe that it serves as an explanation of agricultural crises. It was not my purpose to explain them but to distinguish between the short-term fluctuations of agricultural production, with which business cycles are in some way connected, and agricultural crises occurring comparatively seldom, connected presumably with so-called long cycles. Gumperz does not pay enough attention to this distinction, though it is of great importance. If Gumperz would proceed from a simple scheme of a theory of cycles to a developed and complete theory, he would meet difficulties in including in the same theory the phenomena of frequently recurring business cycles and those of agricultural crises occurring but seldom. He recognizes that in the past agricultural crises were not periodic (p. 21); but he believes that in the future, because of a greater inter-connection between agriculture and industry, fluctuations of agriculture will correspond more closely to the phases of the industrial cycle. It may be true, but the phenomenon which is generally called an agricultural crisis and which we are now observing throughout the whole world is one which occurs seldom rather than frequently. During the more than a hundred years since the Napoleonic wars, there were, perhaps, only three world-wide agricultural crises and they were associated with long periods of falling prices and not with short-term business cycles.

Gumperz rejects the monetary explanation of agricultural crises and in his analysis of the crisis in America, he does not even mention that factor. I fail to see, however, how the monetary factor can be disregarded in the analysis of the present crisis in America. He does not attribute much importance to the post-war condition of the world market. He says that the forces and tendencies acting upon the world market merely intensify and accentuate the difficulties which would exist even without the influence of that factor. The explanation of the crises he finds in the revolutionary changes that have taken place in agricultural technique which require a corresponding reorganization of agricultural enterprises. The crisis in American agriculture, he attributes to the crisis of small-scale farming, not sufficiently capitalistic in its struggle with newly created large capitalistic farms supplied with modern machinery. Gumperz even goes so far as to state in one place that for giant farms (Riesenbetriebe) there is no agricultural crisis (p. 156). The author is too categorical in his conclusions as to the advantages of very large enterprises in agriculture. The benefits of large-scale (giant) farming in some lines of agriculture (such as extensive small-grain farming in semi-arid regions) give him the basis for generalizing for all branches of farming. The problems about which agricultural specialists in this country are still in doubt he solves categorically in favor of the "agricultural factory." His outlook, therefore, concerning the future of family farms in America is too pessimistic. He sees no salvation for independent farmers in this country. They must become proletarians. In one place, Gumperz risks giving an even more concrete forecast by saying that if no modifying tendencies appear, three quarters of the existing independent family farms will have to disappear in some two decades (pp. 160-161).

Gumperz's study often leaves one with the impression that his conclusions are based upon the Marxian scheme rather than upon objective statistical evidences. For this reason the book may give a biased idea about the actual agricultural evolution in America, at least for foreign readers who have no means of verifying the conclusions of the author by personal impressions and observations.

V. P. Timoshenko

University of Michigan

THE

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